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Engineering in Pest Control

BY MAILING a coupon and ten cents, farmers in times past have been able to learn various exclusive new methods of pest control. Most of them were variations of the idea of catching the pest, inserting it between two boards, and applying pressure—an excellent lesson in differentiating between the technically possible and the economically practicable.

It is the job of appropriate biological specialists to determine all of the technically possible means of protecting farm crops from various insect, fungus, bacterial, and weed parasites. Then where energy, materials, or manipulations are involved, as is usually the case, development of equipment and methods for accomplishing the desired control, in a way that can be justified as economical farm practice, is an agricultural engineering job.

Spraying is one well established method in the competition for low-cost crop pest control, low overall cost per unit of production, and increased yield of quality crops. The wide range of materials that can be sprayed, their killing and repellant powers, and their continuing protection in some cases, due to adhesion, suggest its advantages as a control method. It offers agricultural engineering problems and opportunities for improvement in mixing, transportation, pumping, corrosion resistance, diffusion, distribution, control, simplicity of equipment, labor economy, and adaptation to various combinations of pests, crops, and scales of operation.

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Engineering Method in Agriculture

A CONSTRUCTION engineer can build a good barn roof truss, but it takes an agricultural engineer to design a dairy barn for efficient production of high-grade milk.

An electrical engineer may develop or improve an electric fence, light, motor, or other equipment from the standpoint of its electrical characteristics, but fitting it into a program for low-cost production on farms is an agricultural engineer's job.

A mechanical or automotive engineer may improve internal-combustion-engine design to give higher thermal efficiency, but the men who improve tractors from the standpoint of power application and control in farm operations are, in fact, agricultural engineers.

A civil engineer may be the master of water from the standpoint of flow characteristics and control structures, but the control of water for maximum benefit and minimum cost to farm production programs is agricultural engineering.

Such is the neat distinction between agricultural and other branches of engineering drawn by Harold E. Pinches in a paper recently published by "The Yale Review," and summarized elsewhere in this issue.

Agricultural engineers may well and gratefully acknowledge the help of other branches of engineering in the form of principles, designs, materials, and equipment developed which have found, incidentally, a high degree of usefulness on farms and in the specialized progress of agricultural engineering.

But use of the engineering method in agriculture, as suggested by Mr. Pinches, implies much more. It implies defining agricultural problems in terms of marketable forms of materials and energy to be produced efficiently by biological processes, from farm raw materials and energy sources. With a problem thus defined, engineering procedure in agriculture calls for marshalling related physical, chemical, engineering, biologic, and economic facts and tested farm practice into a plan of action for biologically and economically efficient production, or for providing equipment for manipulation and control which will contribute thereto.

In these terms, agricultural engineering is more than a matter of providing mechanical substitutes for the old gray mares of agriculture. It is a method of reducing a farm-operating problem to its lowest understandable factors, and then utilizing science to build up a solution that will stand the test of farm practice and competition.

Confounding the "Doubting Thomas"

WHO DO agricultural engineers represent? Do they represent the engineering profession pushing out to thrust a new salvation upon agriculture, or do they represent an attempt of agriculture to reach out and bring an additional technology to bear upon agricultural problems? History indicates that agriculture initiated a demand for information, equipment, and service which resulted in agricultural engineering development.

All the first improvements in farm equipment were the developments of farmers, or tradesmen who supplied farmers' needs. The early engineers who developed a vision of possibilities in agricultural engineering were farm boys who, when they found an opportunity for higher education, had chosen engineering. They knew and were still a part of agriculture in personal experience, and they saw in engineering certain principles, methods, power applications, and controls which could be applied in farming.

While these scattered few foresaw some of the possibilities of agricultural engineering, the organized older branches of engineering were jealously opposed to the use of the word "engineering" in connection with any such tripe. Early graduates of the pioneer agricultural-engineering courses at the University of Nebraska and Iowa State College had to fight to prove their competence as engineers, and had to join with engineers of other branches who had worked into agricultural engineering, in a still harder fight to justify the existence of agricultural engineering as a distinct branch of the engineering profession. No, the engineering profession has certainly not been guilty of thrusting itself upon agriculture.

The products of agricultural-engineering curricula are still being forced to prove their competence as engineers, and may it always be so. That is a matter of maintaining and even raising the standards signified by the word "engineer." And there still is, and probably always will be, a need of spreading the word of what agricultural engineering is to the ever-changing public, including farmers and our contemporaries in other branches of engineering work. We can scarcely expect, or wish, to be taken for granted.

We can maintain and strengthen our position by remembering that we represent the interests of agriculture, that we must work in a competent engineering manner, and that our primary concern is the engineering inherent in agriculture—the physical facts of agriculture that have been true since the beginning of time; that have been or will be discovered, and can be utilized to make the farm a more desirable place to live and work.

What progressive farmer of today would want to do without the equipment and methods provided by agricultural engineering, which are now commonplaces in his life? What socially-minded engineer would wish to deny agriculture any of the benefits which engineering has given to urban life and industry; to deny agriculture any benefits that it might experience by the specialized training and application to its problems of as many engineers as it may see fit to employ? What citizen-philosopher does not indorse low cost of production for farm products in his own purchases of food and clothing, by trying to get maximum quantity or quality for whatever money he is prepared to pay?

We need not bore those who are already sold on the intrinsic merits of our professional position, but when we meet "doubting Thomases" we can afford to take the time to give them some such food for thought.

MAY

Cases in Chemurgy

NEW AND renewed opportunities for agricultural engineers to aid agriculture through chemurgy were revealed in the Fourth Annual Chemurgic Conference held recently at Omaha, Nebraska. They may be classified under aids to farm production and delivery of either new crops, old crops, or former crop wastes, to meet the requirements of processing industries; or aids to farm use of the new materials being manufactured from farm products.

Newly discovered values in certain varieties of castor bean plants suggest that they might stage a comeback as a farm crop in the United States. Plant improvement to reduce shattering of the seed is on the way. The next need is for a mechanical harvester.

A potential domestic perilla industry also awaits the development of satisfactory harvesting equipment.

Dr. Perrin H. Long, of Johns Hopkins University, pointed to a dangerous dependence of American medicine on imported pharmaceuticals, some of which could be produced in this country. Disturbed conditions in foreign countries interfere with production and delivery, periodically endangering our supply, skyrocketing prices, and offering a speculative opportunity for service, as well as profit. The hitch to production in the United States is harvesting cost; in other words, the lack of efficient harvesting equipment to meet the special requirements of the plants in question.

Agricultural engineers at present are probably doing most for chemurgy in connection with their work of lowering the cost of production of, and thereby widening the market for, the standard farm crops which represent large volume production. Cotton, grains, and soybeans in particular have shown great promise of expanding industrial use, subject to realization of lower production costs. In the case of cotton, production and harvesting methods are already a factor in the grades of fiber produced. It seems likely that, as industrial use of other farm crops increases, there may be demand for production methods and equipment to help meet new and specialized industrial grade and delivery requirements.

Special harvesting of former crop wastes ordinarily left in the field has made little progress, due to added cost factors. However, it is readily possible that in some cases industrial use may result in harvesting and delivery at the processing plant of a larger proportion of the crop plant than is done in present practice, with corresponding modification of harvesting procedure and equipment.

From the utilization standpoint, chemurgy has made available to agricultural engineers a wide range of new engineering materials. Their availability makes possible new specifications; new standards of performance and cost; new opportunities in the design of buildings and equipment.. Their use may improve the farmer's market, as well as his production facilities.

In building materials, the list includes glues, sizings, paints, insulating and acoustical boards, decorative panels, waterproof papers, new cotton fabrics, and artificial stone. Dr. O. R. Sweeney showed at the conference a molded-fiber window frame. This suggests possibilities of reducing the millwork item in building costs. Any agricultural engineers who may have occasion to make recommendations in connection with secondary roads, will do well to inform themselves on the advantages and limitations of cotton fabric road bases. A waterproofed cotton revetment fabric is also available.

Fuel alcohol is being given fair trial by a large number of farmers and automobile owners. More need scarcely be said of it. Soybean meal is finding new usefulness in dust and spray stickers and spreaders. Some other farm-source chemicals for which agricultural engineers may find use are sorbitol, mannitol, furfural, activated vegetable carbon, stearic acid, glycerin, and lignin derivatives.

Arnold P. Yerkes, in addressing the Conference, reminded the scientists and industrialists of the nature of agricultural engineering, and of the fact that agricultural engineers are available to cooperate effectively in furthering the chemurgic program wherever it involves farm operations and production equipment. L. F. Livingston, in his contribution to the Conference program, called specifically for more agricultural engineering research with the direct object of "making farm crops more available for industry." Cost delivered, form and condition of farm products on delivery, dependability of supply, keeping quality, and quality as raw material for industrial use are factors susceptible to influence by agricultural engineering and determining factors in the economy of chemurgic operation.

These are a few of the present indications in farm chemurgy. This cooperative technological and economic movement, under the coordinating influence of National Farm Chemurgic Council, is making definite progress. Agricultural engineers who keep up to date on its developments, will find themselves better qualified to serve their clientele.

Unionization of Engineers

IMPRESSIVE in its apparent sincerity and objective viewpoint is the report of a committee of the American Society of Civil Engineers on unionization of engineers.

Briefly, the report classifies membership in a trade union as an economic matter having no proper bearing on a man's qualification for membership in a professional society; recognizes that some engineers, particularly in the lower brackets of the profession, are underpaid; states that engineers are not and cannot be exempted from the provisions of the Wagner Labor Relations Act in its present form; points to a need of clarifying the position of professional and subprofessional men under the Act; represents existing trade unions as "far from ideal to represent engineers in collective action"; suggests the possibility of "agencies to represent engineers in a dignified professional manner whenever necessary"; and further suggests means of minimizing the need of collective action by engineers to protect their economic rights.

To any agricultural engineer who may have occasion to consider his individual position in the matter, we take the liberty of suggesting an additional consideration. To the extent that he represents agriculture, he represents a class that has seen its markets curtailed at critical times by activities resulting from "the unfavorable characteristics of trade unions as they are known today." His action, if any, may well be based on its probable influence on his economic status, considering not only direct effects, but also the merit of professional ethics and the probable influence of such action on the extent of his opportunity to serve in his professional capacity.

Structural Analysis of Roof Truss Design

By Woodrow Arrington

WITH the demand for higher efficiency and greater speeds, the use of models and model testing has developed into a major phase of engineering. In the field of agricultural engineering, the design of farm buildings often becomes perplexing, especially when unimpaired floor and overhead space are desired, as in shelters or machine sheds. The construction of a model is often quite a bridge between the design on paper and the erected building.

The adaptation of models to framed structures has been retarded by the inconsistent results obtained from usual methods of loading and measuring. Model results can be relied upon only to the extent of the degree of accuracy of their construction, of the methods used in loading, and of the interpretation of the results obtained. Accurate construction, plus a satisfactory system of analysis, will give consistent results that will compare with the results from prototypes. This fact was determined in connection with a comparison made between the results of testing wooden scissors trusses and those obtained from brass wire models using the same pitch and web bracing.

The method of loading adopted in a study at the Idaho Agricultural Experiment Station consisted of a system of levers using the principle of moments, that is, the applied load on the model varies with the distance a known weight is moved along the beam. A second-class lever was used, and this system combined with the principle of moments provided a simple, yet consistent method of loading the models. Fig. 1 shows this lever system mounted on a board for testing a scissors truss made from number 14-gage (Browne and Sharpe), semihard commercial brass wire. By varying the vertical arms and relocating the trusses according to their pitch, this system of levers was sufficient to load all five pitches tested. Trusses varied by one-sixth pitch.

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Author: Formerly graduate assistant in agricultural engineering, University of Idaho. Jun. Mem. A.S.A.E.

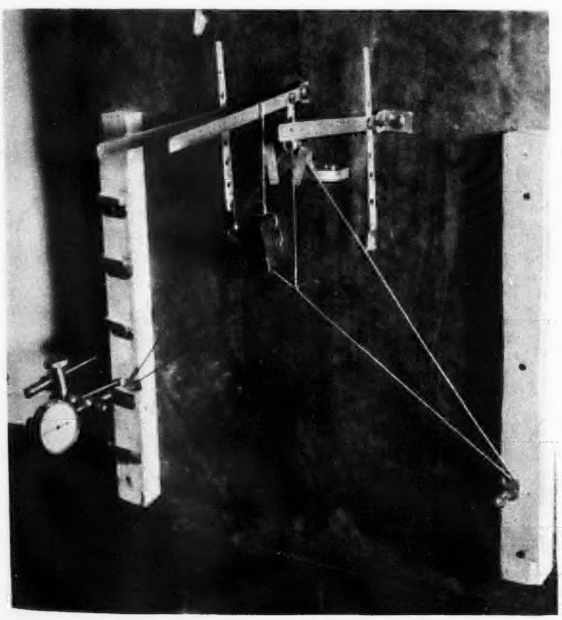


FIG. 1 (LEFT) MOMENT LOADING AND DIAL GAGE FOR ANALYSIS OF BRASS WIRE MODELS OF SCISSORS TRUSSES

With a suitable method of loading available, the development of a method for analyzing or recording the results obtained from this lever system was the next problem. Tracing the deflections, scaling, or direct measurements were not consistent and were discarded. The dial gage shown in Fig. 1 proved suitable for measuring small deflections. This dial gage measures to one ten-thousandth of an inch. This is very accurate for small measurements. To use the dial gage for scissors truss analysis, it is necessary that any movement of the span take place at one support. This was accomplished by using a pin support (assumed frictionless), at the other end. By drilling a small hole in the base plate and using a heavy pin, this type of support was easily provided. To the other support of the truss, a brass shoe was soldered. By placing two or three small steel balls between this shoe and board support, movement with a minimum of friction was provided. At the left of Fig. 1, the brass shoe and support can be seen near the gage mounting. This location of the dial gage records directly any increase or decrease in the truss span.

Substituting the various values from the different dimensioned wooden material in the formula $M = SI/c$, in which M equals moment in inch-pounds, S equals working stress of the material, and I/c equals section modulus of beam. It was found that the ratio of the strength of the beam to bending on edge and the strength when flat was equal to the ratio of the depth to the thickness. For example, a 2x6-in timber on edge has three times the load-carrying capacity of the same timber used flat, or a 1x4-in board on edge is four times stronger than when used flat. With this knowledge, and since only 1 and 2-in material is generally used on edge in constructing roof trusses for most farm structures, it is easy to duplicate each member to scale in a wire model by using a number of different wire gages. Thus the design of a roof truss, as well as the relative importance of each member in the truss, can be quickly analyzed by using wire models.

In early studies the trusses were built and tested similar to previous work carried on with wire models. The use of

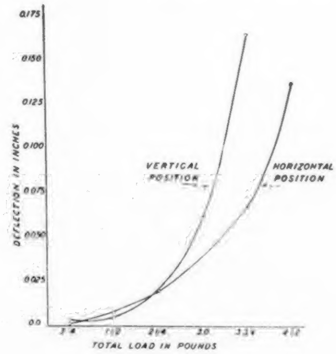


FIG. 2 (RIGHT) SPAN RIGIDITY AS DETERMINED BY MODEL ANALYSIS

gusset plates at all the joints produced a truss too rigid to be distorted accurately. Trusses with plain soldered joints, without gusset plates, proved strong enough and gave a more flexible model which responded to loads of smaller magnitude. To facilitate construction, and yet to be sure that no stresses were induced due to construction, the material was cut to dimension, laid out flat, and held in place with thumb tacks while being soldered. This type of construction was used for all trusses built and tested by this method.

Occasionally a truss is designed for a special need. The fundamental requirement of design, a series of triangles, may be used, yet the truss proves unsatisfactory. Such a case was found in analyzing a truss used in a machine shed. This truss satisfied the requirements mathematically, but practically was unsatisfactory, due to the fact that a member designed to carry tension was in reality a beam. The deflection at its center was sufficient to decrease the rigidity of the truss to a point of incipient failure. Further tests from a model of this truss after a vertical tie was added, which merely divided a large triangle into two smaller triangles, gave excellent results. A known weakness of an actual design and construction was analyzed and remedied from a model study.

Plain soldered trusses constructed of semihard brass wire, which has a high modulus of elasticity, will stand a relatively large distortion without a permanent set. These trusses, when tested with the equipment and method just described, gave consistent results with several check tests. As an example of the results obtained by this method of testing, a comparison is made between simple scissors trusses with the tie member in vertical and horizontal positions. Fig. 2 shows the relative stability of the two designs as recorded by the above system of analysis. As the load is increased on the three panel points, the crosstie scissors truss shows the greatest rigidity. It is known from past experience that members in direct compression are more satisfactory than when in direct tension. This probably accounts for greater rigidity.

The stress analysis of these two trusses by Maxwell's diagram is shown in Fig. 3A and B. A Maxwell diagram is merely a combination of several force polygons, one drawn for each joint and grouped to give a continuous figure. It is a graphical method of stress analysis for each joint in a loaded truss. To anyone familiar with this method of stress determination, the change in stress with the change in position of the tie member can be seen at a glance. The following table gives a numerical comparison of the results obtained from the Maxwell diagram:

Member	Crosstie scissors truss	Simple scissors truss
AF	4.2C	4.2C
BH	0.8C	3.85C
CH	0.8C	3.85C
DJ	4.2C	4.2C
JE	3.4T	3.4T
FE	3.4T	3.4T
HG	5.52C	2.62T
GF	3.4T	0.53C
JG	3.4T	0.53C

By changing the vertical tie in the scissors truss to a horizontal position, the stress in the member changes from tension to compression. Thus the theoretical analysis supports the results as shown by Fig. 2, as to the relative deflection of the span under similar loadings. This system of model analysis provides for the solution of truss designs, yet avoids the laborious task of using diagrams or the solution of simultaneous equations.

The method of constructing a wire model to scale and testing has proven satisfactory. If too small a wire is used, bending occurs before any distortion takes place. With a few trials and using different sizes of wire, this can be easily overcome. The opposite occurs if too large a wire is used; it is too stiff and requires too heavy loads for a true distortion. In rechecking the models, the values obtained were very consistent, indicating that models of structural designs can be tested and checked from time to time.

This method of structural analysis is adaptable to classroom study of farm buildings. Different designs can be studied, improved, or redesigned in an intelligent manner. Soldering permits the addition or removal of a member without disturbing the other members.

Variations in deflections or distortions so small as to be unnoticed by the human eye are *(Continued on page 204)*

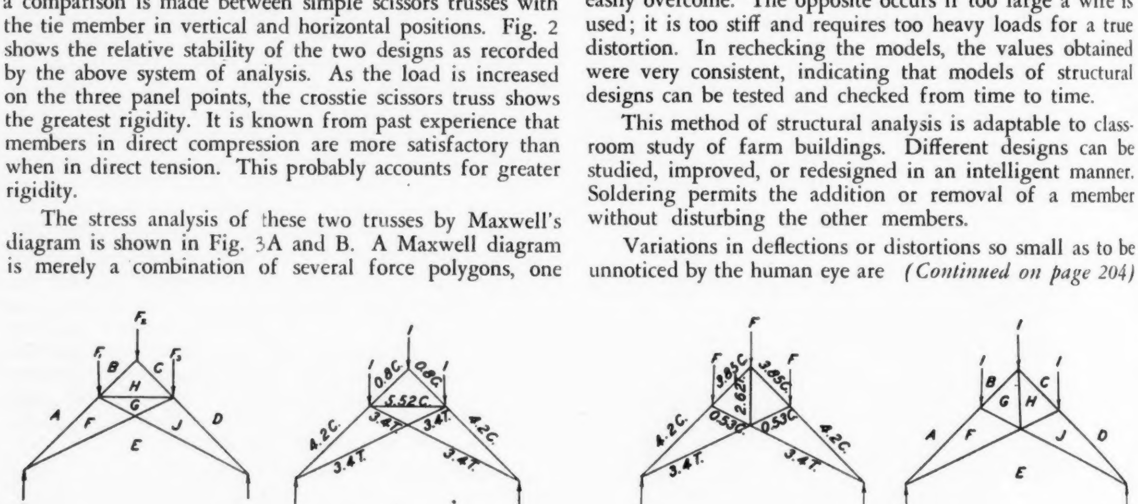


FIG. 3A (LEFT) AND FIG. 3B (RIGHT) STRESS ANALYSIS AND MAXWELL DIAGRAM FOR TWO TYPES OF SCISSORS TRUSSES, AS SHOWN

Modern Connectors in Wood Construction

By John A. Scholten

THE TERM "modern connectors" is generally applied to metal rings or plates and wood disks used in conjunction with a bolt to transmit load between two wood members or between a wood and a steel member. The idea of using some metal device with bolts to increase the strength of the joints is not of recent origin. In fact, the principle of connectors was recognized at least 75 years ago when cast iron plate rings were used in American bridge construction. An American patent on a toothed-plate connector was issued as early as 1889. The possibilities of these earlier types of rings were overlooked, however, because economic conditions had not then furnished the impetus necessary to encourage their development, and the power tools and other facilities required for their extensive use were not accessible.

Introduction of the more modern connectors into this country dates back only a few years, but previous to that they had found extensive application in foreign countries. Since their advent into this country, their use has increased enormously. It is estimated that since 1933 the amount of lumber in structures using connectors is well over 300,000,000 feet, of which approximately one-fifth was used in the specific parts employing connectors. At first their use was confined largely to the intermediate types of construction, but engineers and designers realizing their importance in good wood construction, have extended the scope of their use to both the lighter and heavier types.

To the general public, they are still an unknown book, but to engineers constructing towers, bridges, warehouses, and the like, they are becoming increasingly more familiar. More recently they have entered the field of farm structures, and it is only natural that, with a better understanding of their utility, some of the same improvements which have been effected for other types of wood structures will be extended to these lighter types of framed buildings. While with the present details of construction it may be difficult to visualize the extensive use of connectors in farm buildings, this does not preclude the possibility of changes in design to strengthen the structure and to realize more fully the capacity of the members and joints.

Presented before the Farm Structures Division at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 1, 1937.

Author: Associate engineer, Forest Products Laboratory, U. S. Department of Agriculture. Mem. A.S.A.E.

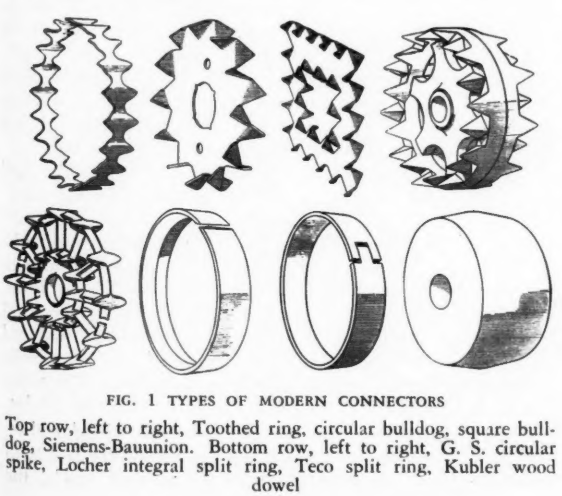


FIG. 1 TYPES OF MODERN CONNECTORS

Top row, left to right, Toothed ring, circular bulldog, square bulldog, Siemens-Bauunion. Bottom row, left to right, G. S. circular spike, Locher integral split ring, Teco split ring, Kubler wood dowel

Joints are a critical factor in any structure. Wasteful practice in timber design results when a member too large for the load it must carry is used, merely to have room for enough spikes or bolts to assure a safe joint.

For certain purposes connectors bring out the strength of the wood more effectively than the best nailed or bolted joint, because they distribute stresses more uniformly over the full section of the timbers. With a bolt or nail the load is concentrated on small areas against which they bear, but with a connector the bearing area is enlarged and is nearer the face of the timbers, where it is most effective. The amount of hardware and labor required for making a connector joint is considerably less than for a bolted joint of equal strength. To obtain the same strength in the most efficient bolted joint would virtually require what has been aptly called a "sewing together" of the timbers with a large number of relatively small bolts.

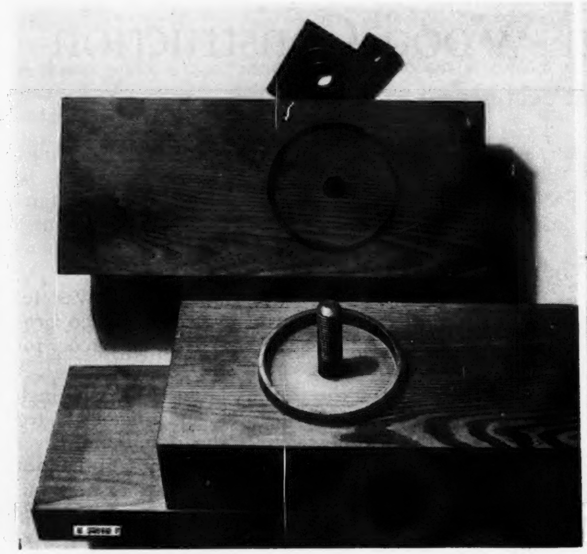
Connectors permit the use of boards and plank in built-up members to replace heavy solid members. This is important because better seasoned material may be employed, and also because, in the future, more of our structural material must be cut from smaller trees. When connectors are used, more complete prefabrication of framing in the shop also becomes possible. Afterward the material can be treated with a preservative for permanence, and erection on the site can proceed rapidly and efficiently, without cutting into the treated surface.

Of the many types of connectors developed, the U. S. Forest Products Laboratory has conducted extensive tests on some of the most promising from the standpoint of American design. These tests have been made to include such factors as type and size of connector, and have furnished the basis for the development of safe working loads. In addition to this, such details as variations in direction of load with respect to the grain, position of the ring in the piece, effect of width and thickness of members, and technique in assembling the joints, have been investigated for various types and sizes of connectors and conditions of use.

There are several types of connectors commercially available in this country, but the three principal types in use at the present time are the split ring, the toothed ring, and the claw plate. Each has its field of application and its advantages for particular purposes.

The split-ring connector is a plain steel ring with a split or break in the perimeter. It is installed in grooves cut to half the depth of the ring in each of the adjacent surfaces of timbers to be connected, and is concentric to a bolt that holds the timbers in contact. It is important that the grooves in the timbers be 2 or 3 per cent greater in diameter than the ring, which requires that the rings be spread and forced into place. The initial stresses thus developed in the ring will be relieved if shrinkage occurs; if swelling should occur, the ring will still fit.

Split rings lend themselves readily to the possibility of



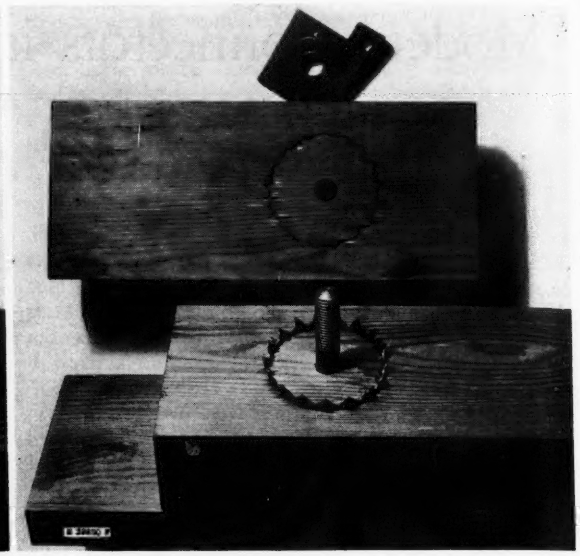


Fig. 2 (Left) Details of split-ring connector joint assembly. Fig. 3 (Right) Details of toothed-ring connector joint assembly

prefabrication. The bolt holes and grooves may be cut at a fabrication plant or on the job. Structures using split rings can also be dismantled and reerected. These connectors are commercially available in 2½, 4, 6, and 8-in sizes. The sizes most appropriate for the lighter frame structures are 2½ and 4-in rings.

The safe loads recommended for these two sizes of split rings in pairs symmetrically loaded, in dry Douglas fir (coast region), western larch, southern yellow pine, and tamarack are shown in the following table:

Inside diameter of ring, in	Depth of ring, in	Diameter of bolt, in	Safe load, lb Parallel with grain	Perpendicular with grain
2½	0.75	½	5,700	4,000
4	1.00	¾	12,000	4,000

These loads are obtained by applying a factor of 3.5 to the ultimate loads, or 1.6 to the proportional limit loads of specimens tested at the Forest Products Laboratory, whichever gave the smaller load. If intermittent loads, such as for wind or earthquake, are of relatively little importance, working loads seven-eighths of those shown in the table are recommended.

A lineal variation between the safe loads for bearing parallel with the grain and those bearing perpendicular to the grain is recommended for angles between these two limits.

The 2½ and 4-in rings may be used in nominal lumber widths of 4 and 6 in, respectively, when the load is applied parallel to the grain or at an angle up to 30 deg from the grain. When the angle of load to the grain exceeds 30 deg in any member of a timber joint, the loads must be reduced unless the edge margin is at least 1½ in, measured from the outside edge of the groove to the edge of the timber. The minimum edge margins permitted for the 2½ and 4-in rings are 0.3 and 0.5 in and are those resulting when these rings are placed in the middle of the face of nominal 4 and 6-in material, respectively. When these minimum margins are used the loads must be reduced 15 per cent. Loads applicable for edge margins between 1½ in, where no reduction in load is required for margin, and the minimum edge margins, should be reduced proportionately between these limits.

The spacing, center to center, of split rings in the same piece with load applied parallel to the grain, and between the end of the piece and the center of the ring nearest the end, should be not less than 1½ diameters to obtain the full strength of the joint. When the load is applied perpendicular to the grain, the spacing of rows of rings should be sufficient to afford at least ½ in of wood between the outer edges of adjacent grooves. The minimum thickness of the members should be nominal 3-in material when connectors are used in opposite faces and 2-in material when the rings are used in only one face.

The toothed-ring type of connector is perhaps more adaptable to lighter construction than some of the other types, especially where power-driven tools to cut grooves or daps cannot be conveniently used. It consists of a circular band of 16-gage, hot-rolled sheet steel with sharp-toothed corrugations. It is placed between adjacent timbers in such a way that it centers on a previously bored bolt hole. The timbers are then drawn together with the bolt imbedding the toothed rings in the adjacent faces. When the timbers are of such a density that they cannot be readily drawn together with an ordinary bolt, a high-strength, alloy-steel bolt with a ball bearing thrust is used and is subsequently replaced with an ordinary bolt. In order to facilitate assembly, the hole for the connecting bolt is bored 1/32 to 1/16 in larger than the diameter of the bolt.

This type of connector is available in 2, 2⅝, 3⅜, and 4-in diameters and 1-in height. The recommended working loads in seasoned timber for two toothed connectors, symmetrically loaded, are given in the following table. These loads were obtained by applying a factor of four to the ultimate loads of specimens tested at the Forest Products Laboratory. For bearing at angles between zero and 45 deg from the grain, the safe loads should be reduced uniformly from those for bearing parallel with the grain to those for bearing perpendicular to the grain. The value for 90 deg should apply for all angles from 45 to 90 deg.

The Siemens-Bauunion connector is a cast circular plate, 3⅛ in in diameter, with a bolt hole in the center and teeth on the side of an eccentric rim. When used singly, the

SAFE LOADS WITH SEASONED SOUTHERN YELLOW PINE OR DOUGLAS FIR (COAST REGION) TIMBERS

Diameter of connector, in	Diameter of bolt, in	Safe load, lb: Parallel with the grain, Bolt tight in hole	Safe load, lb: Parallel with the grain, Bolt in over-sized hole	Safe load, lb: Perpendicular to the grain, Bolt tight in hole	Safe load, lb: Perpendicular to the grain, Bolt in over-sized hole
2	½	2,400	2,200	1,800	1,650
2⅝	⅝	4,200	3,600	3,150	2,700
3⅜	¾	5,800	5,200	4,350	3,900
4	¾	6,900	6,300	5,200	4,700

plate usually has a hub and acts as a stress distributor between a wood member and a metal plate or strap. When used in pairs to join one wood member to another, the hub of one plate fits into the central hole of the other. The connector is partly countersunk and partly embedded in the timber. A groove large enough to incorporate the entire plate, except for the teeth, is cut into the wood, and the toothed face is pressed into this groove until the opposite face is flush with the surface of the wood.

A safe load of 6,400 lb is recommended for two symmetrically loaded Siemens-Bauunion connectors when placed between metal straps and a central timber, and bearing parallel to the grain. This load applies to southern yellow pine, Douglas fir (coast region), and other species of equal strength properties. It was obtained by applying a factor of four to the ultimate loads of specimens tested at the Forest Products Laboratory. When the connectors are used in pairs between a center timber and wood side plates, a safe load of 5,250 lb is recommended for two such pairs, symmetrically loaded and bearing parallel to the grain. The factor to be applied to the loads recommended above, when the bearing is at an angle other than parallel with the grain, is, for 22½ deg, 0.95; for 45 deg, 0.84; for 67½ deg, 0.75; and for 90 deg, 0.72.

A connector known as a shear plate, now being made in the United States, is similar to the Siemens-Bauunion claw plate, but has a heavier hub and is built up at the center on the face opposite to that containing the hub, with an annular rim concentric with the central bolt hole. Tests have shown that when bearing parallel with the grain of the wood, it is capable of carrying a somewhat higher load than the single Siemens-Bauunion connector.

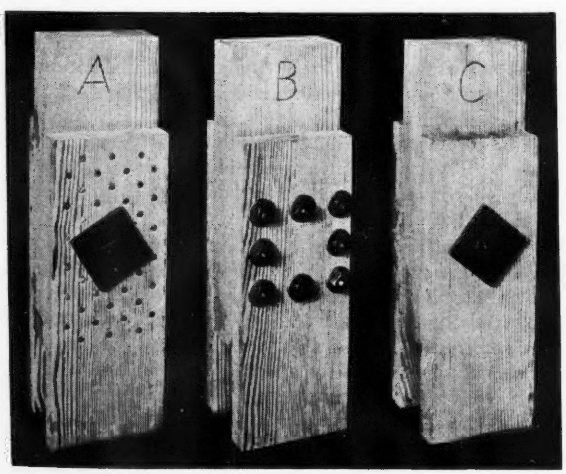


Fig. 4 All joints shown here contain the same weight of metal. The safe load in Douglas fir or southern yellow pine for (A) nails and bolt, 9,000 lb; (b) bolts, 8,400 lb; (C) connectors and bolt, 12,000 lb

The loads which have been listed for different rings apply to Douglas fir (coast region), southern yellow pine, western larch, tamarack, and other species which have comparable strength properties. For material which has been selected for density requirements, as dense Douglas fir and dense southern yellow pine, the loads given may be increased 10 per cent for the toothed ring and 15 per cent for the shear plate and split ring. If the material belongs to a group represented by such species as white pine and white fir, a factor of 80 per cent for the toothed ring and 65 per cent for the shear plate and split ring should be applied to the loads given.

With a better understanding of their behavior, connectors are being modified and improved to meet newer and more general demands. While the types existent today may not meet all of the requirements for a particular structure, the variety of uses to which connectors have already been put attests to their wide application in wood construction. Many of their advantages which have not yet been fully realized will become more evident with increased use. As methods of wood fabrication improve and the inertia against change from the older methods of timber framing is overcome, new adaptations will become more feasible.

Discussion by Ira D. S. Kelly

MR. SCHOLTEN has ably presented fundamental data pertaining to timber connectors used in wood construction and has described the various types of timber connectors available, their installation, and their load carrying ability.

Let me review the characteristic features of this type of construction. Nails, screws, or bolts used in primary strength connections are replaced by timber connectors of suitable type and size and placed with sufficient end and edge distances to allow the connectors to carry their recommended load without damage to the timber. These connectors are installed between the contact surfaces of timbers of adequate thickness, lapped together at strength connections. The timbers are then held together over the connectors by small diameter bolts, so that the connectors can carry the load. The strength thus provided in the connections frequently results in the use of smaller timbers than are otherwise necessary to develop the same strength at the joints with nails, screws, or bolts only. Relatively thin and wide timbers are used in order to secure sufficient lapped area in contact at the joints to receive the connectors. Thus, timber connector farm roof trusses and other types of timber farm structures may be designed to withstand dead load, live loads, wind load, snow load, or any probable combination of such loads, and to provide timber structures adequately strong, and, at the same time, economical in timber required.

The fabrication and erection of timber connector trusses can be done successfully by any intelligent carpenter working from adequately prepared plans. Two methods of fabrication and assembly of structures using split rings are used. In the first method, each piece of the structure is cut to shape, bored for bolts and grooved for split rings, working directly from shop details or from templates prepared from shop details. The structure may then either be assembled as a unit on the ground, with split rings in all the grooves and swung into place by hand or with suitable hoisting equipment, or it may be assembled in place on falsework. In the second method, the timbers are cut to shape, assembled on the ground, holes for bolts bored through all

Author: Structural engineer, Timber Engineering Company.

joints, dismantled and grooved for split rings and reassembled either on the ground or on falsework.

It should be noted that the only fabrication required in addition to that necessary on any bolted structure is the grooving for split rings and that the rings are easily inserted in their grooves during assembly. Grooves may be cut with special tools provided by the manufacturers of split rings. These tools are so made that the resulting grooves are exactly concentric about the bolt holes, and are of the proper diameter, width, and depth. The grooves may be cut by hand, using a grooving tool in a carpenter's brace, or by power using the tool in an electric or pneumatic portable or stationary drill.

It further should be pointed out that the added cost of the operation of grooving is offset by a reduced cost of boring for bolts and that there is a material reduction in the amount of hardware required when split rings or other types of timber connectors are used. Let me illustrate this point by means of two-tension splices, as in the bottom chord of a roof truss.

Assume two 4x8-in timbers dressed S4S are to be spliced with two 3x8-in timber splice plates. Assume the timber to be a 1200-lb-per-sq-in stress grade in bending or tension. If bolts only are used, the splice will require sixteen 7/8x11-in bolts and will carry a safe load of 24,160 lb. If split rings are used, 8 4-in rings and 4 3/4x11-in bolts will be required. Thus, 16 grooves are substituted for 12 15/16-in bolt holes each through three individual timbers and totalling 106 1/2 in, or 8 ft 10 1/2 in of bolt holes. At the same time there will be a reduction of 4 ft bm in the splice timber required, and 36 lb of hardware.

Toothed rings may be used on types of farm structures where it is desired to reduce to a minimum the fabrication required. With toothed rings there are reductions in bolt holes, timber, and hardware required similar to those with split rings. Structures may be fabricated, assembled, and erected by similar methods. The principal difference is that no grooves are required, but instead the toothed rings are squeezed into the fibers of the lapped contact faces of timbers meeting at a joint, using a high-strength rod equipped with double-depth nuts, a ball-bearing washer under one nut and heavy plate washers on each side of the assembled joint. A ratchet wrench with an 18 to 24-in handle is a convenience, if many joints are to be tightened. After the timbers have been drawn into contact over the toothed rings, the high-strength rod assembly is replaced by the ordinary machine bolts of the final assembled joint. This tightening operation does not require a skilled workman. The use of toothed rings is particularly desirable in the majority of types of farm structures.

Shear-plate timber connectors are useful in farm structures wherever it is desired to transfer load from timber to steel, or the reverse. They may be used with steel gusset plates in difficult joints, or with steel devices used for hinges or footings. They are installed in a seat cut to receive the body of the plate and their teeth are forced into the timber with a high-strength rod.

It is understood studies are under way on more modern and practical types of barn structures than used in the past. I refer in particular to studies of a single-story barn contemplating feed storage elsewhere and provision for control of heat, humidity, and ventilation, as well as provision for a high degree of fire resistance and protection from decay. A tentative roof truss design for this barn has been prepared for a span of 36 ft and a rise of about 10 ft 5 in using a Fink type truss with ceiling joist, a ceiling cambered 1 ft 6 in, and purlins with rafters and sheathing for the roof.

The National Lumber Manufacturers Association through its subsidiary, the Timber Engineering Company, and its licensees, will be glad to assist individual agricultural engineers in developing or reviewing specific timber connector designs for any desired farm structure. To that end there are available publications so prepared as to make the choice of the most desirable species and grade of timber easy, to simplify the specification of that timber, and to provide all possible technical data essential to reliable timber design.

Publications available from the National Lumber Manufacturers Association, Washington, D. C.:

Wood Structural Design Data. 296-page handbook of information for architects, engineers, and builders, with supplements on working stresses, bearing strength of bolts, joist and rafter spans, and safe loads for columns. $1.00 per set.

Lumber Grade-Use Guide. 212 pages. Describes manufacture and grading of hardwood and softwood lumber. Tells which grade to use for each part of a building or other structure. $1.50 per copy.

House Framing Details. Isometric drawings of the proper framing of houses. Details of fireplace and chimney construction. 10 cents.

Stronger Frame Walls. How wood walls should be framed for greatest strength. Based on laboratory tests. 10 cents.

Publications available from the Timber Engineering Co., Washington, D. C.:

Typical Lumber Designs. List of 100 typical designs with quantities and material lists for light and heavy frame structures.

Manual of Timber-Connector Construction. A 24-page technical bulletin giving design and use data on TECO connectors for timber construction. This manual contains complete information for the use of engineers in designing timber-connector structures.

Modern Timber Structures. Non-technical bulletin (12 pages) describing different types of connectors and their uses.

Modern Timber Roof Trusses. Typical recommended roof truss designs. (8 pages).

Structural Analysis of Roof Truss Design

(Continued from page 200)

easily recorded by the dial gage. The width of the line used in previous work, when tracing deflections, is many times larger than the difference in deflections between similar models. The joint construction of an open structure is as important as the design itself. Both are essential for the stability of a truss. After noting the results of both the wooden and brass wire models, it is felt that satisfactory joints can not be constructed in models. Either the fastening or the material is too weak in wooden models. Soldering produces a rigid joint that can be duplicated only in welded or riveted steel structures.

Considerable time and care were taken in constructing the first wire models, but with a little practice, the material for the members was cut to length, soldered together, and completely tested in an average of 30 minutes. A small jig was constructed with a span of 12 in, and varying stops for the altitudes. Thus the assembly time for a truss of any pitch was cut to a few minutes. This allows for the construction and testing of a number of trusses in a short period of time. With a system of moments for loading, any combination and type of unequal or equal loads can be applied, thus duplicating snow, wind, or ice loads, as well as unusual or severe conditions that could not be duplicated in actual structure analysis.

Depreciation of Farm Electric Equipment

By Truman E. Hienton

DEPRECIATION charges are often the greatest item of expense in the use of farm equipment. An Iowa study reported that "of the total expense on equipment approximately 40 per cent was usually for depreciation" (5)*. The importance of this cost item in the rapidly widening field of farm electrification is emphasized by the fact that the investment in electric equipment will average nearly $400 per farm (6). Using a conservative estimate of $350 per farm, the total investment in such equipment on farms in the United States, with electric service as of January 1, 1937, would exceed 365 million dollars. A depreciation of only one per cent on this investment would amount to $3,650,234.

Studies have been made in Iowa (2), Kentucky (1), and Georgia (3) which revealed information on the cost and use of farm machinery. However, very few data of this type are available for electric motors in use on farms and for electrically driven farm equipment. Because of this situation, studies were undertaken by the author in March 1932 and continued at intervals until May 1937, to secure such data.

Information for this study was obtained from 111 Iowa farms and 69 Indiana farms on which electric service had been available for more than ten years. These farms were located in various types of farming areas. All of the Iowa farms were visited in 1932, and twenty-eight of them were revisited during the summer of 1936, while the remainder were communicated with by letter in 1937. Indiana farms were first communicated with in February 1933 by letter and questionnaire, and visited early in 1937 to bring the earlier records up to date.

Abstract from the author's thesis for a master's degree in agricultural engineering, presented at Iowa State College June 1937.

Author: Associate in agricultural engineering, Purdue University. Mem. A.S.A.E.

*Numbers in parenthesis indicate references cited at the end of the paper.

TABLE 1. PRESENT, EXPECTED, AND TOTAL AGES AND USE OF FARM ELECTRIC EQUIPMENT

		Pumps	Separators	Milkers	Brooders
Units	No.	79	73	25	9
Units	No.	7	8	2	0
retired	%	8.8	10.9	8.0	0.0
Ave. age,	All	14.2	13.3	11.1	7.3
yr	Ret.	12.6	16.0	9.0	....
Range in	All	5–25	6–25	4–25	5–9
age, yr	Ret.	7–16	11–21	8–10	....
Ave. use,	All	5,323	2,922	7,677	2,010
hr	Ret.	6,078	3,840	6,570	....
Range use,	All	375–27,340	730–12,410	2,190–18,250	300–2,700
hr	Ret.	832–17,520	730–8,212	5,840–7,300	....
Units included in estimate and total age or use		39	23	11	1
Est. life,	Ave.	11.1	9.3	9.4	8.0
yr	Range	1–25	1–40	3–20	....
Est. use,	Ave.	2,281	2,502	7,134	2,400
hr	Range	274–25,530	152–14,600	2,190–17,520	....
Total	Ave.	25.7	20.7	23.0	17.0
life, yr	Range	12–30	10–60	10–45	....
Total use,	Ave.	10,068	5,829	17,153	5,100
hr	Range	2,433–48,545	1,271–31,010	5,475–33,580	....

The following data were obtained on electric motors: Equipment driven, size, make, type, serial number, age in years, days used per year, hours used per day, first cost, present value, estimated life in years, repairs and cost, and physical and service condition. Similar information regarding make, age, use, first cost, present value, estimated life, repairs and repair costs were secured, where possible, for water pumps, cream separators, milking machines, electric brooders, and nine household items.

Data are presented in Table 1 regarding the present age and estimated use of 79 automatic water pumps, 73 cream separators, 25 milking machines, and 9 electric brooders. The estimated life of the various equipment was obtained, where possible, and this, as well as total life and use, is also shown in the table. These figures indicate an average life of 25.7 years for pumps, 20.7 years for separators, and 23.0 years for milking machines. Observations and records showed that wear and accidents are responsible almost entirely for retirements of farm electric equipment.

Of the 79 pumps included in Table 1, 68 were ten years or more old, and of the remaining 11, less than 10 years old, two had been retired. The seven pumps retired were discarded because of damage due to freezing and because of wear. Five were retired at an average age of 14.2 years because of freezing, and the other two were reported worn out at an average age of 9.0 years. Principal repairs required included repacking of the stuffing box, and new belts.

Fourteen of the 73 cream separators listed in Table 1 were less than 10 years old. Seven of the eight retirements were due to wear and the other due to fire. The average age of those worn out was 15.7 years, while the one destroyed by fire was 18 years old. Two owners reported an annual complete servicing of their separators, six reported the purchase of new disks, five that of a new bowl, and two the purchase of new bushings.

The milking machine was operated the greatest number of hours per year of any machine on which records were taken. Of the 25 machines for which data are reported in Table 1, 14 were more than 10 years old and three were more than 20 years old. Two machines were retired at an average age of 9.0 years, one being destroyed by fire and the other traded because the pump needed reboring. Five operators reported that new teat-cup liners were required annually, one required a new pump, another a new pulsator, and a third replaced milking units after 16 years of service.

Nine electric brooders, from 5 to 9 years old, were still operated in their original condition. The hours use listed in Table 1 were based on the estimated time the heating elements were connected to the service. The figure used, 300 hr annually, is based on records obtained from 72 individually metered brooders in Indiana.

A total of 670 electric motors, purchased new and ranging from 4 to 25 years in age,

were included in the study. The average age of the entire group was 12.6 years while that of 71 which had been retired was 10.7 years. Thirty-six or 6 per cent of the motors in service, were 20 years or more old, while 216, or 36.1 per cent, had been in service 15 years or more.

Sizes of motors varied from 1/10 to 10 hp. The exact sizes of all motors were not obtained but were secured for about 500 of the entire group. Nearly one-half of them, 225, were ½ hp or larger and 137, or approximately 28 per cent, were of 1-hp or larger capacity. Fourteen per cent of the group for which the size was ascertained were of 3 hp or larger. There were only three three-phase motors included in the study. The single-phase motors were divided largely into three types: repulsion-induction, split-phase, and universal.

Equipment driven by the motors included in the study ranked in the following order: Water pump, washing machine, vacuum cleaner, cream separator, refrigerator, grain elevator, milking machine, fan, feed grinder, feed grinder and elevator, and other combinations or items.

The total average use of all motors was 3,774 hr, while that for those which had been retired was 1,814 hr. About 60 per cent of the cooperating farmers estimated the total lives of their motors at an average age of 7,768 hr. Use of motors varied widely with the equipment. Motors on refrigerators, milking machines, and water pumps were used considerably longer than those on vacuum cleaners and grain elevators. Two motors, on milking machines 22 years old, had operated a total of 16,060 hr each.

Motor retirements were greatest on water pumps, followed in order by washers, feed grinders, grain elevators, utility, cream separators, milking machines, and refrigerators. Causes for all motor retirements are shown in Table 2.

It is immediately apparent that wear is the most common factor causing retirement. An accident factor, second in importance, includes items in the table, such as lightning, fire, and mechanical breakage. Other factors causing retirement, which are within the control of the operator, comprise more than 40 per cent of the total.

Certain suggestions regarding the installation and care of electric motors on the farm to prevent similar retirements may be made from these results. Motors started automatically should have protection against overcurrent. This is particularly necessary for motors on water pumps and refrigerators. It is required according to the National Electrical Code for motors of ⅛ to 1 hp. Refrigerator manufacturers and pump manufacturers now generally equip their motors with overload protection. The importance of such equipment is borne out by the fact that 23 of the 71 motors retired, or nearly one-third, were in use on automatic water pumps. Only one was equipped with overload protection and that was burned out because the owner blocked the switch closed so that the overload device could not function.

TABLE 2. CAUSES OF MOTOR RETIREMENT

Causes	Motors retired No.	Motors retired Per cent
Wear	24	33.8
Overloading or no overload protection	11	15.5
Bearings worn out or faulty lubrication	9	12.6
Lightning	8	11.3
Low voltage	5	7.0
Fire	4	5.6
Mechanical breakage	3	4.2
Oil soaking	2	2.8
Careless operation	2	2.8
Unknown	2	2.8
Dampness	1	1.4

Companies selling equipment with motors attached or motors alone can render farmers a service by providing them with the right type and size of motor. At least six motors on water pumps that were retired were of the split-phase type. Four others were of only ⅛-hp capacity. The fact that the motors of this size were too small was evidenced by the fact that one company replaced two of them with larger motors free after two years' use on water pumps.

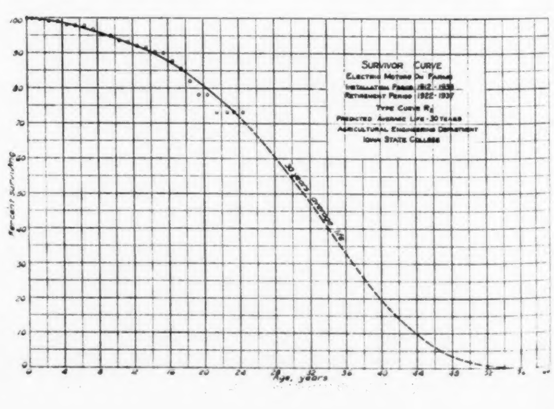
Records taken on 28 washing machines showed that the motors on 19 of them were still in operating condition when the washers were worn out. It would be interesting to know what happened to all of those 19 split-phase motors. At least two of them were burned out on water pumps. There are proper places for them on some farm machines, but the farmer does not always know the machine for which that type of motor is suited. Information is needed by farmers on oiling motors and care of bearings, for 9 of the 71 retired motors were discarded because of faulty lubrication or bad bearings. Five motors were burned out because of low voltage. One farmer in 7 years lost two which were connected to 800 ft of secondary wiring. Farmers and farm wiremen need to know that voltage drop is frequently more important in the selection of a wire size for service to a motor, than is current-carrying capacity.

The life of an electric motor in industrial work may vary from 5 to 28 years according to Marston and Agg (7). An estimated life of 30 years for single or three-phase motors operating feed grinders was used by agricultural engineers of Kansas State College in computing feed grinding costs (4).

Due to the fact that only 10.6 per cent of the motors included in the study had been retired, the data available were treated by the annual-rate method to construct the stub survivor curve in the accompanying figure. The stub curve was then compared with various curves which have been developed by the Iowa Engineering Experiment Station (8). The close agreement in shape of the stub curve with the type R-2 curve led to its use in completing the curve for a predicted average life of 30 years. Separate curves were developed for the three types of single-phase motors included in the study, but the one shown is considered the most reliable because it includes all of the motors retired.

The predicted average life for an electric motor for farm use is of interest to all who may be concerned with farm electrification. It is especially important when depreciation charges are considered in the cost of operating equipment, since it involves an annual cost of 3⅓ per cent instead of the 10 per cent figure now frequently used.

It seems entirely probable (Continued on page 210)



Results of Field Tests on Small Combines

By G. W. McCuen and E. A. Silver

IT BECAME very apparent in 1935 that the small combined harvester-thresher, or "combine," would be accepted as a means of harvesting the many different kinds of small grain crops in Ohio. Farmers were asking for information about these machines. Facts were not available, so a project was set up by the Ohio Agricultural Experiment Station to obtain data relative to the performance of the small combine in the field. The objective of this study was to aid manufacturers in the improvement of their products, and to furnish farmers with information regarding various adjustments, rates of travel, grain losses, and machine and overall efficiencies of the combine.

Test Equipment. The department of agricultural engineering has had extensive experience in testing threshing machines, and it is provided with a satisfactory setup of equipment for that work. After careful planning it was found that this same equipment could be assembled as a single mobile unit, together with an 8-hp, two-cylinder gasoline engine for power. This equipment was mounted on a farm wagon gear with an overall length of 26 ft. A half-ton truck was used to pull the rethresher equipment and to carry much of the smaller equipment. A desk was built in the rear of the bed of the truck. When the tail gate of the truck was lowered and the desk compartment opened, two sets of securely anchored scales were available. Necessary supplies for conducting the tests in the field were carried in the front part of the truck.

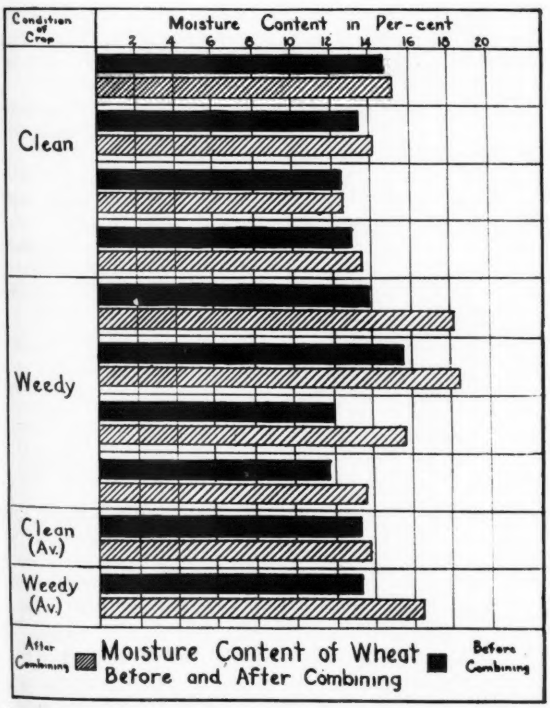
Presented before the Power and Machinery Division, at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 1, 1937.

Authors: Respectively, professor and head of the agricultural engineering department (Mem. A.S.A.E) and research agricultural engineer (Mem. A.S.A.E.), Ohio State University and Ohio Agricultural Experiment Station.

The rethreshing unit was mounted on rubber-tired wheels. A special hitch was designed so that there was no slack in the joints of the hitch. However, a spring hitch was necessary to absorb starting and road shocks which resulted from unevenness in the road and ground surfaces.

Method of Testing. Instead of operating the combine for a definite period of time, it was decided that a more satisfactory method would be to adopt a standard sized area for all machines, irrespective of size of machine. An area of 1/100 of an acre was selected as the standard. The full width swath was always maintained by leaving a small strip of uncut grain. The distance was measured, which, when multiplied by the full width of cut of the machine, would be 1/100 of an acre. Four range poles were set at right angles to the line of travel, with two at each end of the course for accurate "sighting in" purposes at the beginning and end of the test.

Two canvases, usually held by four men, were used to collect separately the straw from the racks and the material from the shoe. As soon as a certain fixed point on the combine came in line with the first two range poles, a signal was given and the canvases were immediately pulled



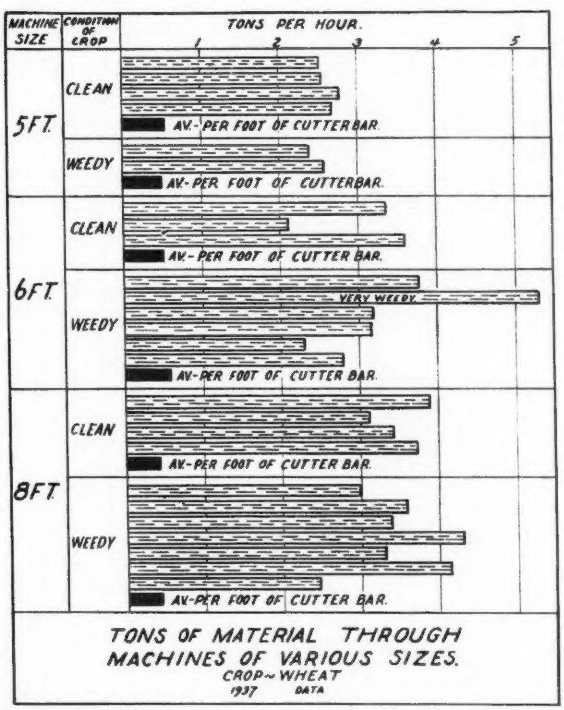


FIG. 1 (LEFT) INFLUENCE OF WEEDS ON MOISTURE CONTENT OF COMBINED WHEAT. FIG. 2 (RIGHT) MACHINE CAPACITIES IN TERMS OF TOTAL MATERIAL HANDLED

up under the straw racks and shoe. As soon as the signal was given denoting the termination of the test, the canvases were released and the combine allowed to proceed. The grain delivered at the grain tank was also collected during this period.

Following the test, the material on each canvas and the grain from the bin was weighed. The material on the large canvas which came over the rack was then fed through the rethreshing unit. An auxiliary shaker separated the loose grain from the straw. This constituted the rack loss. Any unshelled grain in the heads passed on with the straw, was rethreshed, and constituted the cylinder losses. The material on the second canvas, when rethreshed, gave the losses over the shoe.

Cutter-bar losses were obtained by using a square frame representing 1/10,000 of an acre. This frame was dropped on the ground at various points within the test area, and all heads and grains found within this frame were picked up. This procedure was repeated at ten different spots within the test area. This was rethreshed. The total weight of grain secured was multiplied by ten to give the cutter bar losses for the 1/100 of an acre. All rethreshed samples were recleaned, using a small fanning mill, then weighed and recorded.

The combines were first tested as they were found. If the results of the test indicated that the machine was not performing satisfactorily, adjustments were made on the machine, to be followed by a retest. As a rule, tremendous improvement in the machine's performance was accomplished. The reasons and methods for making the adjustments were explained to the farmer.

Very seldom did we find a farmer who was not interested in having his machine tested. Dealers too, as well as manufacturers, were very much interested in these tests, for they welcomed information relative to performance of the machine they were selling or building, when operated by the owners and under different crop conditions.

Following the completion of the tests a report was sent to the farmers, and to the dealers from whom they purchased the machines, giving them facts and information which would be of value to them in the operation and sales of the machine.

Seasons of 1936 and 1937 Compared. The year 1936 was as nearly ideal as could be expected for the operation of combines. The crop was free from weeds, and stood up well. There was practically no rain and very little dew during the entire harvesting season. In some areas several machines were operated continuously for a period of 24 hr. Many were skeptical as to the success of the small combine during the 1936 season.

In 1937 the crop conditions were about opposite to those of 1936, crops being weedy, tangled, and badly lodged. According to the official records, the rainfall in Ohio for July, 1936, was 3.06 in, while for July, 1937, it was 4.27 in. The results of these two years will be given in the remaining part of this paper, providing a comparison between an ideal year and a very bad year, as far as weather and crop conditions are concerned.

During the year of 1936, a total of 26 machines were tested on wheat and oats, and 47 tests were run on these machines. In 1937, 30 machines were tested and 49 tests were made. During 1936 four different makes of combines were studied, and in 1937 there were seven.

Of this number, in 1936, there were eight of the 5-ft size, six of the 6-ft, four of the 8-ft, three of the 10-ft, and five of the 12-ft size. In 1937, there were six of the 5-ft size, eleven of the 6-ft, eleven of the 8-ft, one of the 10-ft, and one of the 12-ft size.

Samples of grain were taken both before and after combining. This was done in order to determine the amount of moisture which the grain collected from the green material in passing through the machine. The samples were taken from both clean and weedy crops.

As was mentioned previously, the year 1937 was an abnormal one when compared to the year 1936. It was to be expected, therefore, that combined grain would have a much higher moisture content than the grain before combining. In 1936 the difference was found to be slight. From Fig. 1, the difference in moisture content before and after combining is rather small on a clean crop, but in weedy conditions the difference is quite great. In practically every case, where there was a considerable difference in moisture content, the straw and weeds were chopped up badly by the cylinder. Through this process the grain picks up considerable moisture as it progresses over the various units of the machine. Very seldom did we find a moisture content of grain, before combining, much above 15 per cent, even in weedy conditions. However, in several cases, the moisture content of grain after combining reached as high as 19.3 per cent. Although grain having this moisture content was accepted by the elevators, it is nevertheless a problem for the farmer if he intends to store the grain on his own farm. The grade was usually lowered because of high moisture content and foreign green material in the grain.

Capacity of the Smaller Çombines. The capacity of combines, based on tons of material through the machine per hour, was somewhat higher in 1936 than in 1937, although the material per unit of volume was much higher in weight in 1937 because of the heavy weed growth. The probable reason for the higher capacity in 1936 was the clean crop, which permitted a higher rate of travel without causing any undue grain losses. In other words, the threshing, separating, and cleaning units could function properly under a large volume of clean, well-matured material.

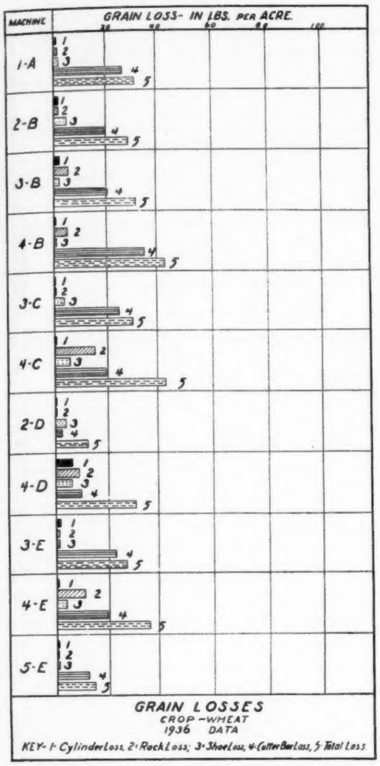
In 1936 and 1937 the average tonnages of material through machines of the 5, 6 and 8-ft sizes are shown in Table 1.

TABLE 1. TONNAGE CAPACITIES OF 5, 6 AND 8-FT COMBINES.

Year	Size of machine	Condition of crop	Rate of travel, (miles per hr)	Average tonnage per hour	Tons per foot of cutterbar
1936	5-ft		3.50	3.54	0.71
	6-ft		3.70	3.76	0.63
	8-ft		3.15	3.69	0.46
1937	5-ft	Clean	3.76	2.66	0.53
	5 ft	Weedy	3.74	2.49	0.50
	6-ft	Clean	3.10	3.02	0.50
	6-ft	Weedy	3.45	3.47	0.58
	8-ft	Clean	2.63	3.51	0.44
	8-ft	Weedy	2.75	3.32	0.42

From the figures in Table 1, it is quite evident that width of cutter bar is not always the limiting factor of capacity. When tonnage per foot of cutter bar is considered (Fig. 2), the machines with the short cutter bar have the high capacity, which leads one to believe that the capacity of a machine depends a great deal on the manner in which the material is handled after it leaves the cutter bar.

Machine Efficiency. The machine efficiency is the efficiency of the mechanical units of the machine. It is based on the cylinder, rack, and shoe losses only. In very few



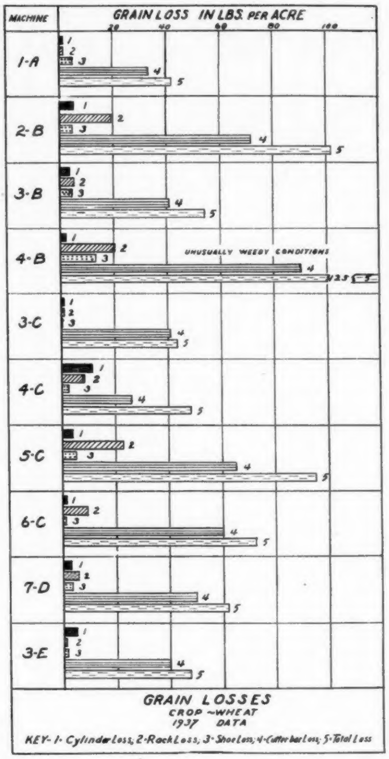


FIG. 3 (LEFT) GRAIN LOSS FROM VARIOUS CAUSES BY INDIVIDUAL MACHINES IN 1936 AND FIG. 4 (RIGHT) CORRESPONDING DATA FOR 1937 UNDER POORER HARVESTING CONDITIONS

the cylinder, rack, and shoe. As in the machine efficiency, the overall efficiency was fairly high during the year 1936. This was due largely to the fact that the grain was standing up well, free of weeds, and the cutter bar could be operated close enough to the ground to catch all heads of grain. Due to broken and down condition of the grain in 1937, the cutter bars of most machines had to be raised to a greater height to prevent overloading the machine and thereby increasing the machine losses. The excessive cutter bar loss, therefore, was responsible in most cases for the low overall efficiency on many machines.

Grain Losses. The grain losses (Figs. 3 and 4) were much less in 1936 than they were in 1937. In the former year the cutter-bar loss, although not exhorbitant, was usually the highest. On many tests, attempts were made to lower the cutter bar in order to reduce this loss, but in so doing the machine losses either at the rack or shoe were increased out of proportion to the decrease in cutter-bar loss. The result was an increase in total grain losses. The cylinder loss was usually the lowest of all the machine losses. No machine in 1936 showed an average total grain loss of over 42 lb per acre. The lowest average total loss of any machine in 1936 was 11.3 lb per acre.

cases was the first test taken as a representative one. It was usually necessary to make two or three or even four tests before the machine was properly adjusted. The results given in Table 2 are, therefore, the average results of tests when the machine was in proper adjustment. Much help in adjusting machines was secured from service men of the various companies.

During the year 1936 the matter of proper adjustment was not so necessary as it was during the 1937 season. It was not unusual to find machines bordering close to the 100 per cent mark. This was true regardless of the type, make, or size of machine.

However, during the 1937 season conditions and results were somewhat different, although it must be said that the results were surprising when the kind and condition of the material going through the machines was considered. In many cases the crop was completely down, and through it had grown a heavy mat of weeds. One machine on the first test gave a machine efficiency of 99.8 per cent, and on this it was not necessary to make a retest. Another machine showed an efficiency of only 82.6 per cent on the first test. It was necessary to make four tests on this machine to put it in proper adjustment. Another machine showed an efficiency of 65.3 per cent, and by adjustment an efficiency of 91.9 per cent was ultimately reached. There was little difference in the efficiencies of machines of various sizes. The small machines, following adjustment, showed as high efficiency as the larger 10 or 12-ft sizes. In fact, in many cases they showed higher efficiency.

Overall Efficiency. The overall efficiency is the efficiency of the method of harvesting which includes the grain losses back of the cutter bar, in addition to the machine losses at

Entirely different results were found in 1937, but even with the poor harvesting conditions many machines were

TABLE 2. MACHINE AND OVERALL EFFICIENCIES

Machine and size	Year	Efficiency in per cent Machine	Overall
1-A	1936	99.6	97.9
	1937	99.2	95.9
2-B	1936	99.3	97.9
	1937	97.2	90.1
3-B	1936	99.1	97.3
	1937	99.0	95.4
4-B	1936	99.5	97.5
	1937	99.4	96.8
3-C	1936	99.6	97.9
	1937	99.7	94.1
4-C	1936	98.0	96.4
	1937	95.8	93.2
5-C	1937	97.3	90.2
6-C	1937	99.0	94.1
2-D	1936	99.4	99.5
4-D	1936	98.5	98.9
7-D	1937	99.3	90.6
3-E	1936	99.5	97.2
	1937	99.5	96.2
4-E	1936	99.8	97.3
5-E	1936	99.6	99.5

found to be doing a very satisfactory job and others were wasting grain heavily. In many cases, however, the grain losses were in direct proportion to the efficiency of the operator. One machine was found to be wasting grain at the rate of 398 lb to the acre, while another had a total loss of 303 lb to the acre. In general, and including the two previously mentioned machines, the cylinder loss was never unreasonably high. In fact, in most cases the cylinder loss was too low because overthreshing was being done, making the rack and shoe losses excessive. The largest grain loss existed back of the cutter bar, but this should be expected because of the weed growth and down and tangled condition of the grain. The cutter bar loss was always more than one-half the total grain loss. The size of machine (based on width of cut) had little or no effect on grain losses. Some of the smaller sizes had lower grain losses than some of the larger ones. Some types of straw racks were found to be more efficient than others.

Effect of Machine Adjustment on Grain Losses. In 1937 practically all machines were found to be out of adjustment to meet the weedy conditions and the down and tangled grain. Most farmers were absolutely ignorant of the grain their machines were losing. It seems that most farmers still rely upon the experience gained by threshing from the shock, which we found does not hold for combine operation. In fact, if we found a machine where the cylinder loss was exceptionally low, we at once became suspicious of a high rack or shoe loss, or possibly both. In other words, overthreshing was being done. The material was broken up too finely, which had a tendency to clog the openings in the straw racks and sieves.

Farmers, as a rule, will test the efficiency of threshing by examining the heads of the grain to determine if any kernels are still unthreshed. If any are found, then it is considered that a poor job of threshing is being done. For instance, in machine No. 1 (Fig. 5), the cylinder loss is quite small, the rack and shoe losses are extremely high, and the cutter bar loss is small. It is evident, therefore, that overthreshing is being done. The straw rack and shoe are overloaded. This particular machine, as well as being out of adjustment, was cutting low because the farmer desired to get as much of the grain as possible through the machine. He did not figure that the total loss would be much less had he raised the cutter bar of the machine slightly.

Adjustments on this machine were as follows: The concaves were lowered, the sieves opened two notches, and the cutter bar raised. With these adjustments a tremendous

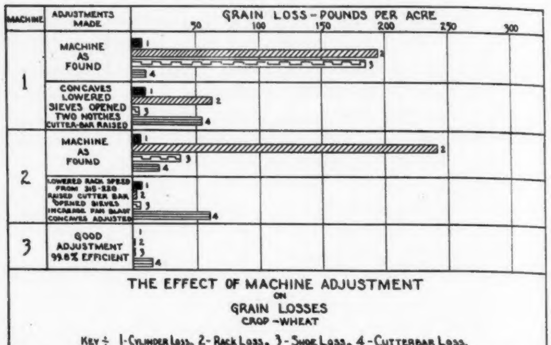


FIG. 5 LOSS REDUCTION BY ADJUSTMENT OF MACHINES

reduction in loss of grain was secured. The cylinder loss went up only slightly, with a tremendous reduction in rack and shoe losses, the shoe loss being the lowest. Another machine, No. 2, was found having an exceptionally high rack loss with a low cylinder and cutter bar loss. Rack speed was reduced from 315 to 220 rpm. The cutter bar was raised, the sieves opened one notch, the fan blast increased, and the concaves adjusted. Rack loss came down from 240 to approximately 5 lb per acre. Shoe loss was reduced considerably, although the cutter bar loss went up. Total losses, however, after the machine was adjusted were much less, as compared to those when the machine was found out of adjustment. The No. 3 machine was one found to be in perfect adjustment and which tested 99.8 per cent efficient. One could readily notice the efficient operation of this machine. The operator not only examined the heads of the grain but was careful to find out whether or not any grain was coming over the straw racks and shoe. In this particular instance, only five kernels of grain were found in the heads on a 1/100 part of an acre. This is evidence of the fact, therefore, that if a machine is to be expected to work efficiently in weedy as well as in clean crops, the cylinder must be of such type and adjustment that it will not break up the material any more than necessary to get the grain out of the heads. Otherwise, straw racks and grain shoes of present design will become overloaded, resulting in tremendous losses of grain. When one stops to consider the loss as found on machine No. 1, it was costing this particular farmer $9 per acre to harvest his wheat instead of the usual figure of $2.50.

Depreciation of Farm Electric Equipment

(Continued from page 206)

from this study that electric motors properly selected as to size and type, properly installed with adequate wiring and overload protection, and properly serviced with regard to lubrication and bearings will last almost indefinitely on farm equipment. All agencies related to farm electrification can help the farmer attain this goal. The educational agencies, including extension specialists, county agents, and vocational teachers; the commercial agencies, which include power companies, farm equipment, and motor manufacturers, can all assist the farmer with his electric motor problems.

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A Complete Water-Disposal Plan Using Vegetation in Terrace Outlets

By John M. Downing

IF TERRACES are to be used in the soil conservation program on all the farms where they are needed, it is imperative that farmers pay the cost of terracing, and of establishing or constructing terrace outlets and waterways to carry the runoff from terraced fields. Under the old method of farm planning and terrace construction that cost has been prohibitive. Many of us have heard farmers on tours say that certain work was fine but that it surely cost a lot of money. Sometimes they have said, "Give me that much money and you can have the farm."

The answer of the U. S. Soil Conservation Service in South Carolina has been to give to the farmer a water-disposal plan that utilizes vegetation as the principal control measure and reduces cost of labor and supervision. The procedure of making and carrying out the plan contrasts sharply with older methods of terrace planning and construction.

In the past, the practice has been to consider only one field at a time, and to use artificial outlets almost exclusively. The first step was to determine in what direction the terraces would drain. After the system of terraces had been planned and the necessary outlets located, construction of the terraces was begun. Only after they had been completed was thought given to building the terrace outlet. Use was made of whatever type of construction the engineer considered necessary to control the runoff. In many instances the necessity of keeping down the cost per acre of the job forced the engineer to concentrate in a single outlet channel the water from an area that might have been drained into several natural outlets. The practice of using artificial waterways does not readily permit the spreading of water from terraces, and to concentrate it requires expensive structures —structures that but few farmers have the money or the experience to build.

When terraces are thought of as a part of the surface drainage system of a farm, terrace construction is readily seen to be one phase of a complete water-disposal plan for the entire farm. In the work of the Soil Conservation Service the adoption of such a plan has made it possible for the supervising engineer to coordinate the types of treatment of outlet channels that are recommended by field engineers. This is also a plan in which the farmer can participate to a far greater extent than was possible under the older practice of terrace construction, because vegetation can be extensively employed.

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Before a water-disposal plan can be drafted it is necessary to make a complete reconnaissance of the farm in order to obtain information on degree of erosion; soil types; present and possible future land use; head water; the size, shape, slope, and cover of drainage areas; material available for erosion control measures; permissible lengths of terraces; and the location of natural outlets, ponds, lanes, gullies, and badly eroded areas. With this information the engineer can make a plan for the farm.

This plan consists of both a map of the farm, which an experienced engineer can readily make, and a schedule of operation that provides for timely and economic development of each field and drainageway.

The map should show the boundary lines of fields, land use, approximate relief, extent and type of cover, location and size of gullies, location of available natural outlets, existing roads and ditches, streams, and buildings. The drainage area in the proposed system of terraces should be sketched in and the location of all terrace outlets and the recommended treatment for each outlet indicated.

The schedule of operation is indispensable because vegetation can be used effectively, only if it is well established before water from terraces is discharged onto it. It is necessary, therefore, to plant the terrace outlet channels or meadow strips long enough before the terrace is constructed to allow for adequate growth.

VEGETATION FOR THE PROTECTION OF OUTLETS

Usually on any farm there are one or more natural outlets that are in condition to serve an adjoining field immediately. This field should be terraced first. The outlets and meadow strips for other fields can be planted or sprigged when the first field is terraced, and the terracing delayed until vegetation has become well established. Perhaps a badly eroded area bordering a cultivated field is so located that it can be planted to vegetation and may become a satisfactory disposal area in a few years. Or perhaps plantings can be made in an adjoining woodland area where the stand is not sufficiently dense to take water from terraces. After several years these woods can probably safely receive runoff water from a terraced field.

In thus caring for water disposal by preparing outlet channels before they must carry the water from terraced fields, the engineer and farmer are taking advantage of what nature can do if made a partner in terracing. This method of planning has been practiced in South Carolina for the past twenty months. There, under normal conditions, areas planted to *Lespedeza sericea* have received water from terraces two years after having been planted; those planted to annual lespedeza, one year after the planting had been done. Kudzu meadow strips proved to be satis-

factory outlets two to four years after they were planted. Fertilizer and lime have been used on all of these areas.

If the farmer is financially able and has labor available, he may plant and set out all necessary vegetation the first year after the water disposal plan has been made. As a rule, however, most farmers will establish control measures in only one or two fields each year.

How the plan works can best be illustrated by reference to the accompanying sketch of the water-disposal plan for one of the farms under agreement.

Field No. 1 on this farm should be terraced first, because on two sides of the field are woods into which the terraces can be emptied without damage.

In field No. 2 the topography and location of roads are such that two terrace outlet channels are required. Channels No. 4 and No. 5 are located to drain into woods and woodland pasture respectively. When the terracing machine is on the farm for terracing field No. 1, it can be used to excavate these two terrace channels. The farmer can then scarify and sprig sod broadcast. In one year's time the terrace channels should be sufficiently developed to take water.

In the lower section of this field where all the terraces drain directly into the woods, the terraces cannot be constructed until the undergrowth in the woods has been made dense enough to take care of the runoff from this part of the field. Trees can be planted here the first season after the plan is made. After several years' growth the woods should be dense enough to prevent the washing that would have been caused had the terrace water been emptied into the original woodland.

In field No. 3, 200 feet of Bermuda sod terrace outlet channel running into a meadow strip is recommended. The outlet channel section can be cut when either field No. 1 or No. 2 is terraced. The meadow strip can be disked and sown to *Lespedeza sericea* the first season after the plan is made. No land is lost to crop production, even though the field is not terraced for several years, because the sericea will produce hay by the second year. If the sericea is sown in grain during the early spring a grain crop can be had the first year. Meadow strips are possibly the easiest control measures for the farmer to establish.

For field No. 4 one meadow strip and two Bermuda terrace outlet channels are recommended. This meadow strip can be established when the meadow strip in field No. 3 is planted. The outlet channels can be cut when those in field No. 2 are prepared, or later if the farmer finds it more convenient. There are two gullies in this field that are to be filled and terraced across. The field will be ready for the terracing equipment when the vegetation in the gullies, the outlet channels, and the meadow strip has become well established.

The only equipment needed that is not usually found on a farm is a machine to excavate the terrace outlet channel. This work can be done cheaply by cooperative county terracing machines on a rental basis.

Under the old plan it would have been necessary for farmers to postpone the preparation of terrace outlet channels until after they had been able to secure the use of the terracing equipment for their farms. Because of the small number of terracing machines available in each county farmers will be delayed in the excavating of terrace outlet channels. Farmers who have complete water-disposal plans can begin at once to make their fields ready for terracing, and can distribute both planting and terracing over several years.

In demonstration project and camp areas of the Soil Conservation Service, it has been the responsibility of the engineer in charge to train young or inexperienced engineers in formulating water-disposal plans. Under the old procedure of planning a field today and beginning construction of the terraces tomorrow, the supervising engineer did not see the job until it was under construction or completed—when it was too late to institute recommended changes. The requirement that a water-disposal plan of the whole farm be made when the farm is put under agreement gives the supervising engineer a chance to look over the plans and make any recommendations for changes before construction and plantings have been begun. This arrangement has not been found to add to supervisory duties, but, on the contrary, has decreased the time required for supervision by cutting down the number of trips to the farm during the course of construction operations.

EFFICIENT USE OF CCC AND FARM LABOR

Another advantage of the complete water-disposal plan is that it allows greater flexibility in the work program of the CCC camps. When terrace outlet channels were established after construction of terraces had been completed, the amount of work done by the CCC enrollees and the time when it could be done were determined by how much the tractors could do. During certain seasons of the year when weather conditions did not permit steady construction, the CCC camps were often required to do work of very little value while waiting for better weather, when construction could be resumed. The water-disposal plan for each farm coordinates the construction of terraces and outlets, but changes the sequence of construction so that the work of the camps can be arranged independently of terrace construction operations.

Our records show that the cost of vegetated waterways put in before terraces are constructed is one-fifth that of waterways established after construction of the terraces. This difference is primarily in labor cost. It reflects a reduction in the time required on a job, and this means that under the new plan the camps can execute more jobs and reach more farmers.

THE CARD INDEX

In project areas and in counties where CCC camps are located a card index of proposed work is made. There is a card for each type of work—meadow strips, rock masonry dams, Bermuda terrace outlet channels, contour furrows, tree plantings. As each water-disposal plan is finished and agreed to by the farmer, each job listed on the plan is entered on its respective card. Such an index records on one card or set of cards all the farms on which plantings of any one kind are to be made. It is, therefore, virtually impossible that any farm agreement be missed at the time the planting agreed upon can properly be made. When the season for planting trees comes, it is possible for each farmer to find out quickly where trees are to be planted. And the same is true of the other vegetative plantings. On each card is shown also the name of the cooperator, the farm number, the field number, the approximate length and width of the area to be planted, an estimate of each job, and the date of completion.

Water-disposal plans for the farms in South Carolina call for the construction and planting of approximately 2,000 terrace outlet channels and 400 meadow strips within the next six months. When the present plans in South Carolina have been executed there will be 110,000 acres of land for which water-disposal systems will have been established before the construction of terraces begins. It is the belief of the Soil Conservation Service engineers in South Carolina that the water-disposal plan for the entire farm furnished the best method of carrying the engineering part of the conservation program to soil conservation districts, which farmers are now organizing.

Effect of Degree of Slope and Rainfall Characteristics on Runoff and Soil Erosion

By J. H. Neal

FACTORS affecting soil erosion are so many and so varied that it is difficult to determine the relative importance of each individual factor, especially under natural conditions. Even on small areas, the soil varies widely in its physical characteristics and conditions, and in its ability to produce vegetation. Rainfall characteristics are so varied that the erosion caused by one rain can seldom be compared with that produced by another. The moisture condition of the soil at the time of a rain, the soil structure, the surface condition, and the vegetative covering are continually changing.

It is the purpose of this paper to present the results of a study of a few factors affecting erosion which were obtained by setting up a miniature laboratory-controlled field on which the degree and length of slope, the rainfall intensity and duration, and the soil conditions were regulated or measured.

Rainfall intensities of 0.90, 1.50, 2.00, 3.00 and 4.00 in per hour were employed. The slope was varied between 0 and 16 per cent, usually by geometric progression.

After each rain, the soil was restored as nearly as possible to its original condition and the moisture content was determined.

EXPERIMENTAL PROCEDURE

A Putnam silt loam surface soil from a timothy meadow was placed in a wooden soil tank 12 ft long, 3.63 ft wide (area, 1/1000 acre), and 2 ft deep. Soil in the tank was 16 in deep and overlaid a 6-in stratum of sand and gravel to provide free drainage. The sides and back of the tank

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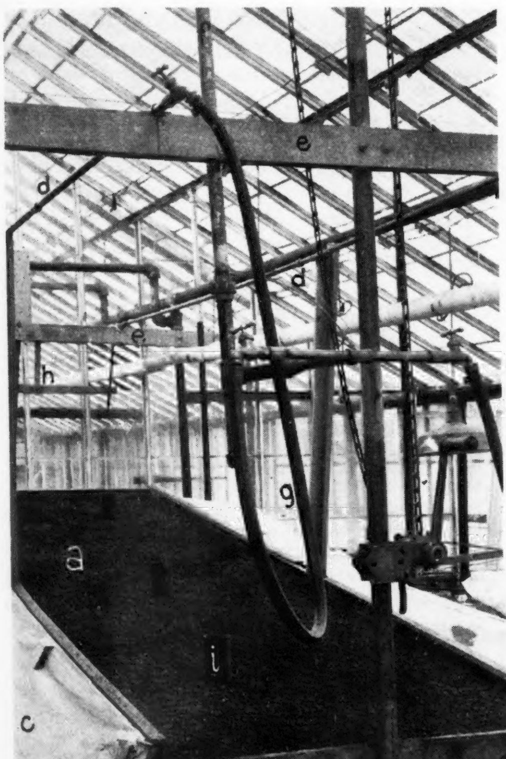
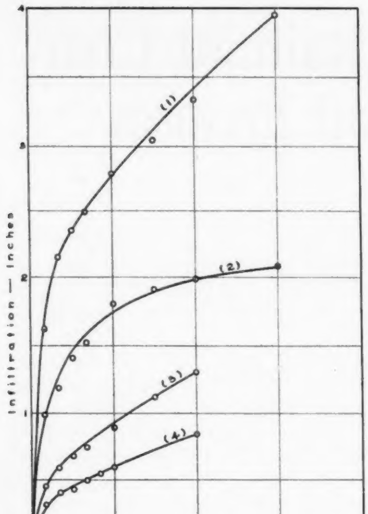


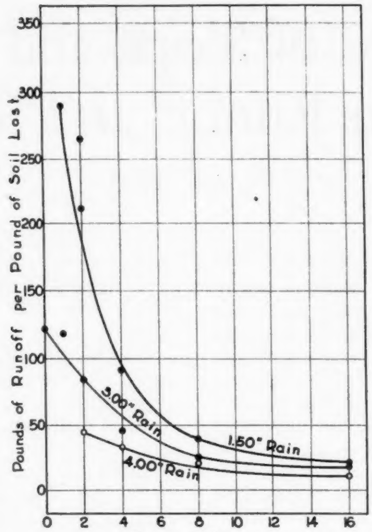
FIG. 1 (LEFT) THE EXPERIMENTAL TANK SETUP

a, soil in soil tank as it was prepared for a run;
b, trough to catch runoff;
c, apron to catch overthrow water;
d, sprinkler pipe;
e, sprinkler pipe supports;
f, down pipe from overflow supply tank;
g, hose connection from supply tank to sprinkler pipe;
h, oscillating lever, and
i, infiltration cylinders

FIG. 2 (BELOW) DETAILS OF SOIL TANK CONSTRUCTION

a, pipe on which soil tank was mounted;
b, wooden bearings to give a greater bearing surface on pipe and to keep soil tank from slipping on the pipe;
c, joists (four 2x8s) supporting soil tank;
d, trough in which percolation water was caught and carried to one side;
e, side of soil tank, and
f, apron to catch overthrow water, hanging along side of soil tank while not in operation





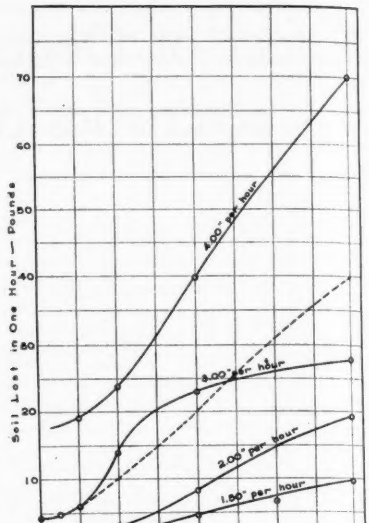


Fig. 3 (Left) Total infiltration into soil in tank (1) before erosion tests were started and before the soil, below a depth of 10 in, had reached capillary capacity; (2) after erosion tests were made and after the soil, below a depth of 10 in, had reached capillary capacity; (3) infiltration during a 3-in rain on a flat slope, and, (4) average infiltration during all rains. Fig. 4 (Center) Effect of slope and rainfall intensity on relative density of runoff material. Fig. 5 (Right) Pounds of soil lost from 1/1000 acre for different rainfall intensities on slopes ranging from 0 to 16 per cent

extended 2 in above the soil. A 10-in pipe served as a pivot for the tank (Figs. 1 and 2). The pipe was set one foot off center and a screw jack was set under the heavy end to change the slope from 0 to 16 per cent.

Physical Characteristics of the Soil. The soil used in the tank was classed as a silt loam, but had a higher degree of aggregation than most Putnam soils. Forty-three per cent of the particles smaller than 0.1 mm were in aggregates larger than 0.1 mm. The physical characteristics of the soil are given in Table 1.

TABLE 1. PHYSICAL PROPERTIES OF THE PUTNAM SOIL

Characteristics	Value
Apparent specific gravity (lb per cu ft)	78
Real specific gravity	2.3
Upper plastic limit	31.2
Lower plastic limit	23.8
Plasticity number	7.4
Moisture equivalent	23.7

Preparation of the Soil for Each Run. Before each run the soil was dried, and cultivated to a depth of 4 in. Usually additional amounts of soil were added after each run to bring the surface elevation back to the original height. This additional soil was taken from a reserve supply with a moisture content about 50 per cent of the capillary capacity. It was worked into the surface soil so that it would not form a dry stratum. After the soil was approximately leveled off with a rake, a wooden templet was drawn the length of the box and all excess soil scraped off. Since the templet left the soil in a smooth condition, a rake was run lightly back and forth across the slope to simulate the condition of a good seedbed. The soil was left in this condition for 2 or 3 hr with a fan circulating the air over it. The surface inch of soil was further dried to between one-fourth and one-half the capillary capacity before applying the rain.

Soil Moisture Determinations. Just before each run, duplicate soil samples were taken with a core sampler at depths of 0-1, 1-4, and 4-10 in. Similar samples were usually taken immediately after each run.

The Sprinkling System. Two sprinkler irrigation pipes with the nozzles spaced 9 in apart were placed 4 ft above the soil when the tank was level. The sprinkler pipes were placed 3.65 ft apart, so that a pipe was directly over each side of the soil tank (Fig. 1). The pipes were set so that the nozzles on one side were half way between those on the other side.

With the exception of the 4-in application of rain, the water was applied through 60-gage standard nozzles. The 4-in application was obtained by using 57-gage nozzles under the same head as for the 3-in application. The latter nozzles had a stem extending out about an inch from the pipe. A nozzle with a stem is better suited to artificial rain application than the standard sprinkler nozzles as the direction of the spray can be adjusted by bending the nozzle by a light blow.

Application of Rain. After the soil was ready and the soil tank set at the required slope, the rain was applied at a constant intensity for periods of 1 to 6 hr. The first three runs with rain intensities of 1.50, 2.00, and 3.00 in per hour were applied on an 8 per cent slope for a period of 6 hr. These first runs were made by varying the rain intensity on a constant slope, but after that the procedure was changed to vary the slope with a constant rain intensity. Rain intensities of 0.90, 1.50, and 3.00 in per hour were applied for a period of 3 hr on all except the 8 per cent slope. Rain intensities of 2.00 and 4.00 in per hour were applied for only one hour.

During the rain application, the pipes were oscillated manually at an average rate of one complete oscillation every 2 to 4 sec. In addition to the oscillations the pipes were moved longitudinally a distance of about one inch every 10 to 12 oscillations until a distance of 9 in (nozzle spacing) had been reached, then the direction was reversed.

While oscillating the pipes, a small quantity of water was thrown outside the soil tank. This was caught on an

oilcloth apron, carried to one end, and discharged into a can. The overthrow or lost water was weighed every 20 min and the quantity subtracted from the total quantity sprinkled during that time.

The infiltration, the runoff, and the soil losses were determined at 10-min intervals, under cultivated conditions, for (1) slopes ranging from 0 to 16 per cent, (2) rain intensities ranging from 0.90 to 4.00 in per hour, (3) rain duration ranging up to 6 hr, and (4) different initial moisture content and surface conditions of the soil.

INFILTRATION

The rate of infiltration was determined (1) by applying water in cylinders forced into the soil and (2) by the difference between rainfall and runoff. Two series of tests were made by the cylinder method, one before the erosion tests, while the soil moisture content was considerably below its capillary capacity, the other after the erosion tests, while the soil moisture content, below a depth of 4 in, was equal to its capillary capacity. The rate of infiltration during the first cylinder test was 1.5 to 1.9 times that of the second cylinder test (Fig. 3). Under either condition, the rate of infiltration was much greater than the infiltration during a rain. In the cylinders the water was applied gently, and it neither puddled the soil nor carried suspended material into the soil pores, while under rain conditions the surface soil was puddled and undoubtedly much suspended material was carried into the pore volume of the soil. The average infiltration during rains (rain minus runoff) was from one-third to one-half that obtained for similar soil conditions when applying the water gently in a cylinder.

Initial soil moisture content had a greater effect on the rate of infiltration during the first 20 min than any other factor. After a period of 30 min, the rate of infiltration became very slow, and after one hour it was approximately uniform. When the rain intensity was greater than the rate of infiltration, there was no appreciable difference in the rate of infiltration for different rain intensities.

The highest rate of infiltration during a rain occurred on a zero slope when 3.19 in of rain per hour were applied. Inasmuch as there was a sheet of water 1/4 to 1/2 in deep over the soil surface, the falling rain drops dissipated their energy in the water rather than by dispersing the soil. Also having a sheet of water over the surface created a pressure head which induced a higher rate of infiltration. The next highest rate of infiltration occurred on a 16 per cent slope when 4.04 in of rain per hour were applied. This case had the lowest initial soil moisture content.

As a whole, the data indicate that, for slopes of 1 to 16 per cent inclusive, the rate of infiltration was not a function of the slope.

RUNOFF AND SOIL LOSSES

Effect of Slope. It is generally recognized that soil erosion increases as the slope of the land increases, but the relationship between slope and erosion losses has not been very definitely worked out. One of the objectives of these experiments was the determination of the effect of the degree of slope on runoff and soil erosion.

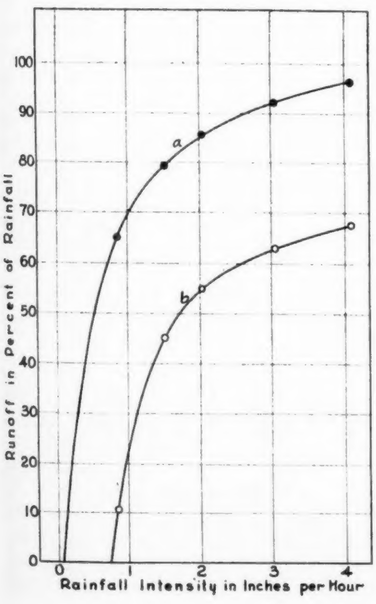
It was found that slopes above one per cent apparently had little or no effect on the per cent of runoff. After the surface soil was saturated, the runoff was 65 to 98 per cent of the rainfall, depending upon the intensity.

On slopes of 4 per cent or less, no gullies were formed. On 8 per cent slopes, a few small gullies occurred, especially for the heaviest rains. However, on 16 per cent slopes, gullying was very noticeable.

The relative density of the runoff material increased as the slope increased (Fig. 4). For 3.00 and 4.00-in rains, the amount of runoff required to remove one pound of soil was four times larger for a 2 per cent than for a 16 per cent slope, while for a 1.50-in rain nearly ten times as much runoff was required to remove a pound of soil from a 2 per cent as from a 16 per cent slope.

Soil losses from the flatter slopes, 0-2 per cent, were not materially different for any given rain intensity. As the slope became steeper than 2 per cent, there was a substantial increase in soil loss (Fig. 5).

Soil losses resulting from the 3.00-in rain did not follow the same trend as did the results from the other rains. The broken line, Fig. 5, shows the results which would have been obtained, had the trend followed the characteristics of the other rains.



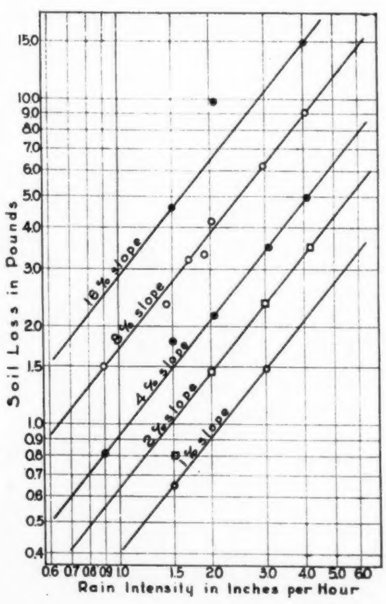
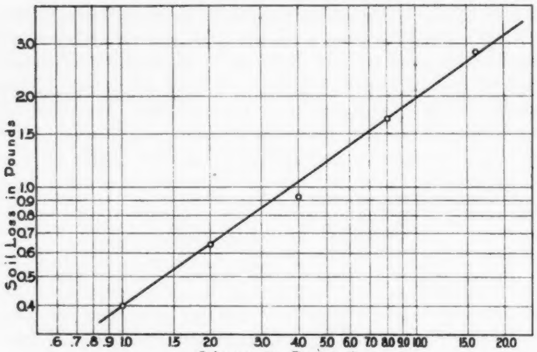


Fig. 6 (Extreme Left) Effect of rainfall intensity on the per cent of runoff when one inch of rain fell on (a) a saturated soil and (b) a dry soil. Fig. 7 (Left) Pounds of soil lost from 1/1000 acre as a result of one inch of rainfall at various intensities



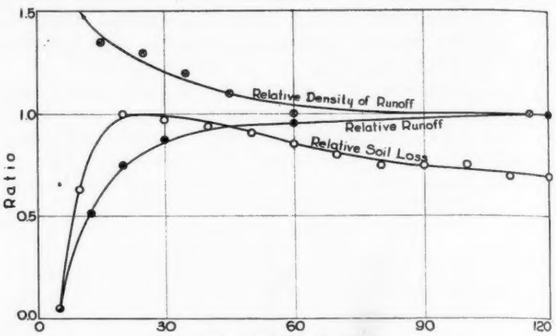


Fig. 8 (Left) Pounds of soil lost from 1/1000 acre as a result of one inch of rainfall in one hour on various slopes. Fig. 9 (Right) Effect of duration of rain on relative density of runoff, relative runoff, and relative soil loss

All the curves are slightly S-shaped, but the one for the 3.00-in rain is decidedly so. That is, the soil losses from slopes between 8 and 16 per cent did not increase in the same proportion as the losses from slopes between 4 and 8 per cent. The S-shaped characteristic was more pronounced for the shorter duration, and less evident for rains continuing for an hour or longer. The soil losses from rains falling on a saturated soil usually showed an increasing rate of soil loss as the slope increased.

Effect of Rain Intensity. The results of these tests showed that the effect of the rain intensity was by far the most important factor affecting runoff and soil erosion.

Since the rate of infiltration was about the same for all rain intensities of 1.50 in or more per hour, the total runoff increased as the intensity increased (Fig. 6).

The rain intensity had a greater effect on the soil loss than on the runoff. After checking over the results, it was found that the soil erosion losses bore a geometric relationship to the rain intensity. To get this relationship, it was necessary to reduce the other variables to unity or to a constant. To eliminate the effect of the initial soil moisture content, the quantities of soil lost were taken after the rain had been falling for 30 to 60 min. Since the 2.00 and 4.00-in intensities were applied for only one hour, it was necessary to take the values from the second 30-min period, while for the 0.90, 1.50 and 3.00-in rains, the values were taken from the second and third hour.

To get a comparison of the different rainfall intensities, the quantity of rainfall was taken as one inch (unity). The duration of the rain used in the tests was the time, in minutes, in which it took one inch of rain to fall.

Since the amount of soil lost had been determined for each 10-min interval, it was possible to secure, by interpolation, the amount of erosion as a result of one inch of rain falling at intensities ranging from 0.90 to 4.00 in per hour. For a given rain intensity on a given slope, it was assumed that the erosion loss, in pounds, from a saturated soil varied directly as the duration of the rain in minutes. This assumption was very nearly correct for erosion losses resulting from rains which had continued for periods greater than one hour. However, the soil losses resulting from rains whose duration was less than one hour would not have come to equilibrium. The losses would be too large for rains of high intensity and too small for rains of low intensity. The pounds of soil lost as a result of one inch of rain on a saturated soil are plotted as a function of the rain intensities in Fig. 7.

For one inch of rain on any given slope, the rate of erosion varied as the 1.2 power of the rainfall intensity. The value 1.2 is the slope of the logarithmic graph.

That is, $E = K_1 I^{1.2}$ [1]

Where E = erosion from 1/1000 acre in pounds
K_1 = a constant for any given slope
I = rain intensity in inches per hour.

Since K_1 is the value of E when $I = 1$, these values of K_1 for each slope can be plotted as a function of the per cent of slope and a graph (Fig. 8) is obtained which gives the erosion loss from different slopes for one inch of rain, when the intensity is unity. From this graph the erosion loss was found to vary as the 0.7 power of the per cent of slope. For one inch of rain on any slope the erosion is

$$E = K_2 S^{0.7} I^{1.2} \qquad [2]$$

Where K_2 = a constant = 0.4, which is the value of E when both S and I are unity
S = slope in per cent

If a different quantity of rain than one inch fell, then equation [2] must be multiplied by R (the amount of rain), but $R = IT$, or intensity multiplied by time in hours. Then for any quantity of rain, the erosion loss is

$$E = 0.4\, S^{0.7}\, T\, I^{2.2} \qquad [3]$$

Equation [3] gives the soil loss caused by a rain falling on a saturated soil. In case the soil is not saturated, several additional factors must be included in the equation. The most important of these are (1) the duration of the rain, (2) the effect of the initial soil moisture content, and (3) the effect of the condition of the soil surface. Each of these factors are discussed under their respective headings.

Effect of Duration of Rain. To determine the effect of the duration of a rain at a constant intensity the first three runs were continued for a period of 6 hr.

After runoff started, there was a continual increase in the rate of runoff until the infiltration rate had become approximately constant. The increase in the rate of runoff and the decrease in the rate of erosion were very slight between the first and second hours (Fig. 9), and after the second hour they were approximately constant.

When runoff occurred during the first 10-min period after the rain started, the maximum soil loss usually occurred during the second 10-min period. By taking the soil loss during the second 10-min period as unity, it was

found that the average soil loss during the first period was 0.63 and for periods after the second, the ratio decreased until only 0.70 as much soil was being lost during a 10-min period between 1½ and 2 hr after the beginning of the rain as during the second 10-min period. When runoff did not occur until the second 10-min period, the maximum soil loss was likely to occur any time from the third to the sixth period, except for the 0.90-in rain, when it occurred still later. During the second hour there was usually a decrease in the amount of soil lost. At the end of the second hour 0.80 as much soil was being lost as during the fourth 10-min period.

The density of the runoff decreased during the first hour of the rain. When the rain continued longer, the density remained approximately uniform (Fig. 9).

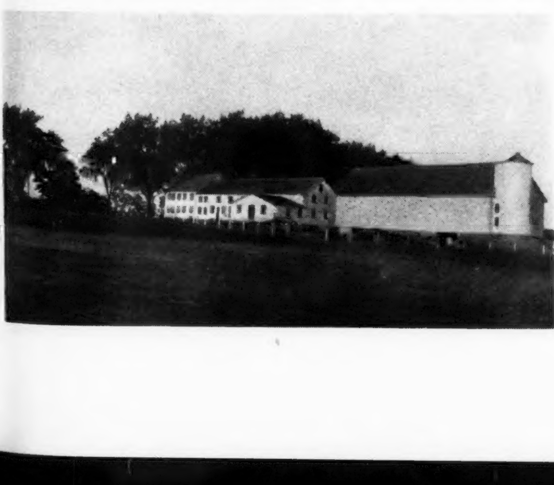
As a rule 1½ to 2 times as much runoff was required to remove a pound of soil at the end of one hour as at the beginning of the rain.

Owing to the opposite trend in the per cent of runoff and the density of the runoff material, the rate of soil loss increased during the first 20 to 40 min, then decreased during the next hour. After about 90 min, the soil loss was approximately constant (Fig. 9).

When the soil was in a very dry condition, a large portion of the rain, especially at the beginning, was absorbed; consequently there was little or no runoff. Although the first runoff which occurred had a high density, the small quantity resulted in a relatively low soil loss. As the soil moisture content increased, the per cent of runoff also increased, but the density of the runoff did not decrease until a moisture point was reached where the soil would no longer slake upon wetting. When this point was reached the rate of erosion loss decreased. Above this moisture content, there was no appreciable variation in the rate of erosion for given slope and rain intensity.

The following theory is presented as an explanation of the above phenomena. When rain falls on a dry soil, the soil is slaked and thrown into suspension. If the rainfall intensity is high enough to cause runoff in a few minutes after the rain starts, this suspended material is carried off. Rain falling on a moist soil only packs it down and creates a pavement effect which sheds the water, but does not erode as severely as a soil originally in a dry state. In case a rain continues to fall on a soil that was originally dry, the suspended material is soon washed away and the remaining wet soil packs down into a smooth pavement-like surface. Although the runoff increases, the soil losses decrease. Results substantiating this theory were obtained in every case.

Effect of the Condition of the Soil Surface. The condition of the surface of the soil at the beginning of the rain was an important factor in relation to runoff and soil loss. Two inches of rain were applied in one hour on an 8 per



cent slope under the following conditions: (1) normal, (2) very dry pulverized surface, (3) rough, dry surface spaded 4 to 5 in deep, and (4) dry, hard, baked surface.

In the normal run the soil was prepared in the manner previously described. The very dry pulverized surface was prepared in a similar manner, except that it was worked and dried for a longer time before applying the rain. Also the soil which was added was in an air-dry condition. The rough, dry surface was prepared by spading to a depth of 4 to 5 in after the surface was dry, and then allowed to dry again without further disturbance. The dry, hard, baked surface was dried without working.

On the regularly prepared surface, as previously described, runoff occurred in 7 min after the rain started, while on the dry pulverized surface, runoff did not occur until 12 min after the rain started.

The density of the runoff from the regular run was higher than that from the dry pulverized surface. The average quantities of water required to remove one pound of soil for the runs were 39 and 70 lb, respectively.

The runoff from the rough spaded surface did not start until 26 min after the beginning of the rain. During the first 30 min, 0.99 in of rain was absorbed or held by the depressions, and 0.04 in ran off, while during the second 30 min only 0.27 in of rain was absorbed by the soil and 0.76 in ran off. An average of 49 lb of water were required to remove one pound of soil.

CONCLUSIONS

Infiltration was not affected by either the slope or the rainfall intensity, but varied inversely as the initial soil moisture content.

Percentage of slope had no apparent effect on the percentage of runoff for slopes above one per cent.

Percentage of runoff increased as the rain intensity increased, but at a decreasing rate.

When the soil was dry before a rain, runoff did not occur until several minutes after the rain started. The time elapsing between the beginning of the rain and the time when runoff occurred, decreased as both the slope and the rain intensity increased. After runoff started there was a continual increase in the rate until the infiltration rate had become approximately constant. This occurred 1 to 2 hr after the beginning of the rain.

Density of the runoff material decreased during the first hour of a rain. When the rain continued longer, the density remained approximately constant.

From 1½ to 2 times as much runoff was required to remove a pound of soil at the end of one hour as at the beginning of the rain.

Relative density of the runoff material increased as both the slope and the rainfall intensity increased.

Soil losses from a saturated soil increase as the 0.7 power of the slope, the 2.2 power of the rain intensity, and directly as the time of duration of the rain.

The amount of erosion from a soil which was in a dry condition at the beginning of the rain was affected by the initial soil moisture content and the condition of the soil surface, in addition to the degree of slope, the rain intensity, and the duration of the rain.

A soil in a dry, pulverized condition or one in a dry, rough condition will absorb much more rainfall than one in a smooth, hard, baked condition.

"Engineering's Biggest Job"

UNDER this heading "The Yale Review" published in its spring issue a paper by Harold E. Pinches, head of the department of agricultural engineering at Connecticut State College. The title refers, of course, to agricultural engineering in its broadest sense.

The concept of engineering upon which the paper is based, is defined in the words "Engineering is the method of determining and marking clearly the boundaries of a problem, and then of marshalling scientific fact and tested practice, out of which a plan of action is projected."

Picturing large structural works as the distinguishing feature of a first stage of engineering, and machines for increasing man's work capacity as the mark of a second stage, the author amplifies his definition by saying "We have now reached a third stage, in which we have come to think so objectively of the characteristic engineering processes that they can be applied confidently, as a distinctive set of methods, to almost any sort of practical problem."

Asking the rhetorical question "Can these methods be applied to agriculture?" the author points to characteristic differences between agriculture and urban industries, and cites numerous examples of the type and extent of engineering problems and opportunities in agriculture.

"Three fields in agriculture may be distinguished as the provinces of engineering. They are the planning of the necessary structures, soil and water control, and energy control. These are not the whole of agriculture, but through them all of agriculture is affected; through them power and labor, the largest items of variable cost, are controlled. Here are the largest hopes of reducing further the human costs—the real costs—of agricultural production."

He also distinguishes between the services of the fundamental branches of engineering to agriculture, and true agricultural engineering, in part as follows:

"The distinction between the service of engineering in agriculture and agricultural engineering may be suggested by illustrations. When the construction engineer designs a windproof truss for a barn, he is giving agriculture valuable aid in meeting one of its persistent problems. When the electrical engineer replaces expensive fencing with one strand of electrically charged wire, he helps reduce the cost of handling livestock. The standpoint of either man might still be that of the construction engineer or the electrical engineer. But when the engineer goes into such a question as how best to design a dairy barn from the functional side, considering the labor and sanitary conditions required for efficient production of high-grade milk, he becomes in a broad sense an agricultural engineer. A man might work long and successfully on fuels for tractors and be no more an agricultural engineer, than if the work were being done on racing cars; but if he turns his mind to the control of the power of the tractor and its application to farm production, he becomes an agricultural engineer. Likewise, a true agricultural engineer learns that the prevention of erosion is not a simple matter of structures but of drafting a soil and water program which involves crops, farming practices, and farm reorganization.

"The concentration of the sciences behind the older lines of engineering on ponderable mass and mathematical formulation, tends to keep the engineer's eyes fixed on certain specific problems, so that he does not see his work as a method of procedure. But if he takes this broader view of it, the application of his method to agriculture presents itself as a separate and distinct field."

Predicted as some of the probable important future contributions of agricultural engineering to agricultural development, are the following:

1. Displacement of labor, of which the author says, "Immediately, questions of definition of efficiency and progress arise, involving the whole social tangle of the results of technical advances. But, in the long run, no theory of human progress is tenable which does not aim at the substitution, wherever this is feasible, of mechanical energy for human energy. The resulting dislocations are not the measure of the worth to humanity of the technical advance. Rather they are evidence of ill-adapted social and economic institutions."

2. Strict environmental control for biological production, facilitating development in agrobiology and agrochemistry.

3. Increasing the use factor on farm buildings and equipment.

4. Elimination of many farm "chores" by automatic and semi-automatic machines.

5. Revision of field practices and of tillage and harvesting equipment.

In conclusion, the author says, "Many branches of science and technology must play their part in the advance of agriculture, but the quantities of energy used are so vast, the total of human labor is so tremendous, and the physical structures are so numerous and costly as to present to engineering a challenge to find in this field its next and largest job."

Bindweed Control by Clean Cultivation

By H. W. Gerlach

BINDWEED or "creeping jenny" is receiving such widespread attention in many sections of the country, and such specific attention as is demonstrated by the new Kansas noxious weed law, that it certainly requires the undivided attention of the agricultural engineer. He must find a control method that will be economically practical for areas where relatively low yielding crops predominate.

Some of the most complete and exhaustive attempts at eradication have been carried on at the Hays experiment station of the Kansas Agricultural College. Clean cultivation, smother crops, sodium chlorate spraying, salting, and close grazing control methods have all been tested. This article will deal with the results obtained from the clean-cultivation method. The results of tests made definitely indicate that the reasonable cost of the clean-cultivation method makes it thoroughly practical and desirable, particularly for relatively low-value agricultural land. The control method is simple and effective, and can be carried on either with large county-owned outfits, or with equipment as regularly found on the average Great Plains farm.

Control by this method is based primarily on starvation of the plant. Like many other perennial plants, the bindweed has an exceptionally extensive root system that maintains a large supply of plant food in reserve. For efficient control of the plant the cultivation method must be carried on repeatedly throughout the year. Tests were carried on chiefly with duckfoot or blade type cultivators. The blades or sweeps should overlap each other in such a way that a complete shearing action on the roots is obtained. A similar action is impossible with a disk or shovel type cultivator as these act merely as uprooting agents.

The most effective control program starts with an early spring cultivation when plant growth is active, and at a time when moisture and climatic conditions are optimum. Interrupting the supply of plant food at this time causes an exceptional drain on the food reserve of the roots. When control is started in the fall months due to the drier conditions of the soil and less favorable climatic conditions obtaining, there is little growth in the plant following the cultivation operation so there is little exhaustion of the food reserve.

Cultivations should be made periodically, allowing 8 or 10 days of plant growth between cultivations. The program should be carried on for 15 or 16 operations. When plant growth is permitted to go a longer period between cultivations, or when cultivations are made more often, the results have been less favorable as it appears that there is less drain on the food reserve of the roots. Apparently it sums up that 8-day top growth permits the plant to reach such a stage that interruption causes the greatest strain on the root system. At the Hays station it developed that deep cultivation is little, if any, more effective than cultivation carried on at 6 to 8-inch depths. A summary of operation costs follows:

COST OF ERADICATING BINDWEED ON 120-ACRE FIELD

Equipment:	1 "Caterpillar" D6 Diesel tractor	
	1 MH-10 hitch	
	3 10-ft John Deere field cultivators	
	Time to cover 120 acres	16 hrs
	Acres per hour	7½
	Diesel fuel per hour	2¼ gal
	Operator's wages per hour	$0.31
	Tractor cost per hour	$0.85
	Implement costs per hour	$0.65
	Total costs per hour	$1.81
	Once-over cost per acre	$0.24

NOTE: Costs shown are for once over, and includes fuel, grease, oil, and repairs and depreciation reserve for tractor and hitch computed at 10 per cent yearly and for cultivators at 20 per cent yearly amortization. The tests indicate sixteen cultivations in one season give practically complete eradication.

If normal spring rainfall is lacking, it is desirable to delay the initial cultivation so as to permit the plant to reach a vigorous growing condition, as they kill better when growing vigorously.

A second type of control program, while less effective than the strict summer fallow program, but one giving good results if consistently followed for 3 years is a program of six cultivations practiced at two-week intervals and finishing the last one about October 1, and immediately planting wheat behind the duckfoot. It is believed this program will be more favorably received by farmers as it permits the growing of wheat each year which, in a measure will pay an appreciable part of the eradication program costs. This latter program while less effective than the strict summer fallow program still appears to be quite satisfactory.

EQUIPMENT CONSISTING OF TRACTOR AND DUCKFOOT CULTIVATORS, USED AT HAYS, (KANS.) EXPERIMENT STATION IN A STUDY OF THE CLEAN-CULTIVATION METHOD OF BINDWEED CONTROL

Author: Agricultural engineer, Caterpillar Tractor Co. (Mem. A.S.A.E.)

Program - Annual Meeting

American Society of Agricultural Engineers

Asilomar, Pacific Grove, California June 27 to 30, 1938

SUNDAY, JUNE 26

1:00 to 8:00 p.m.—Registration (Social Hall)

5:00 p.m.—Council meeting (Merrill Hall)

8:00 p.m.—Lecture: Marine Life Along the Monterey Coast—*Dr. Rolf L. Bolin*, Hopkins Marine Station, Stanford University
(Chapel)

MONDAY, JUNE 27

4:30 to 5:30 a.m.—Low Tide Feature Trip
(Minimum annual low tide)

8:30 to 10:30 a. m.—College Division Program
(Merrill Hall)

Presiding: *E. G. McKibben*, division chairman

1 Progress of the A.S.A.E. Student Branches
 (a) Reported by the Committee on Student Branches—*D. A. Milligan*, chairman
 (b) Reported by the National Council of Student Branches—*Edwin J. Stastny*, president
 (c) Reported by a faculty adviser — *Clyde Walker*, Oregon State College

2 Status of Agricultural Engineering in the Land-Grant Colleges and Universities
 (a) Administration, facilities, and students—*H. E. Murdock*
 (b) Curricula—*F. R. Jones*

3 Report of Committee on Curriculum Rating—*Dr. J. B. Davidson*, chairman, Committee on Curriculum Rating

10:30 a. m. to 12:30 p.m.—Group Programs
(Class Room Building)

I — AGRICULTURAL ENGINEERING EXTENSION

Presiding: *J. R. Haswell*, general chairman, Committee on Extension

ROUND TABLE: Who Is Doing What (in Extension)?

1 *W. R. Schoonover*, citriculture specialist, University of California

2 *J. B. Brown*, extension specialist in irrigation, University of California

3 *K. J. T. Ekblaw*, agricultural engineer, American Zinc Institute

II — AGRICULTURAL ENGINEERING RESEARCH

Presiding: *E. A. Silver*, general chairman, Committee on Research

Round-table discussion on agricultural engineering research

III — STUDENT GROUP

Presiding: *Edwin J. Stastny*, president, National Council of A.S.A.E. Student Branches

(PROGRAM IN THE MAKING)

2:00 to 4:00 p.m.—Group Programs
(Class Room Building)

I — RESIDENT INSTRUCTION GROUP

Presiding: *F. R. Jones*, member, Advisory Committee, College Division

1 Report of Subcommittee on Summer School in Industry—*E. W. Lehmann*, chairman

2 Report of Committee on Education—*H. E. Pinches*, chairman

3 Report of Committee on Relations with Vocational Education—*F. W. Peikert*, chairman

4 Instruction in Rural Electrification—*T. E. Hienton*, in charge of rural electrification, Purdue University

5 Agricultural Hydrology—*Dr. M. L. Nichols*, assistant chief, division of research, U. S. Soil Conservation Service

II — AGRICULTURAL ENGINEERING EXTENSION

(2:00 to 3:00 p.m.—Separate sessions of the Public Service Group and Private Industry Group of Committee on Extension. 3:00 to 4:00 p.m.—Joint session of whole Committee on Extension.)

III — STUDENT GROUP

Presiding: *Edwin J. Stastny*, president, National Council of A.S.A.E. Student Branches

(PROGRAM IN THE MAKING)

4:00 to 5:30 p.m.—Hike along ocean beach at low tide to see marine life

8:00 p.m.—Lecture: The Monterey Peninsula—*Dr. Aubrey Neasham*, Monterey historian, University of California.
(Merrill Hall)

TUESDAY, JUNE 28

8:30 to 10:30 a. m.—General Program
(Merrill Hall)

Presiding: *Arnold P. Yerkes*, President of the Society

1 Meeting opened by *Walter W. Weir*, chairman, local committee

2 President's Annual Address: *Arnold P. Yerkes*, editor, "Tractor Farming," International Harvester Co.

3 Water and the Land—*S. H. McCrory*, chief, Bureau of Agricultural Engineering, U. S. Department of Agriculture (1938 John Deere Medalist)

4 A Profile of Farm Electrification in America—*George A. Rietz*, chief, rural electrification section, General Electric Co.

10:30 a. m. to 12:30 p.m.—Technical Programs

I—POWER AND MACHINERY DIVISION

(Merrill Hall)

Presiding: *F. P. Hanson,* division vice-chairman

SYMPOSIUM: Special Farm Machinery Developments and Applications on the Pacific Coast (6 min each)

1 *J. P. Fairbank,* extension specialist in agricultural engineering, University of California

2 *F. E. Price,* agricultural engineer, Oregon Agricultural Experiment Station

3 *O. C. French,* junior agricultural engineer, University of California

4 *H. L. Garver,* rural electrification investigator, State College of Washington

5 *Hobart Beresford,* head, agricultural engineering department, University of Idaho

6 *B. D. Moses,* associate agricultural engineer, University of California

7 *Roy Bainer,* associate agricultural engineer, University of California

8 *H. B. Walker,* head, division of agricultural engineering, University of California

9 *Bernard L. Hagglund,* district representative, Caterpillar Tractor Company

10 *S. W. McBirney,* U. S. Bureau of Agricultural Engineering

II — RURAL ELECTRIC DIVISION

(Class Room Building)

Presiding: *F. E. Price,* division chairman

1 Precooling Vegetables by Water Spray—*R. L. Perry,* assistant professor of agricultural engineering, University of California (10 min)

2 Electric Pasteurization of Milk—*Ben D. Moses,* associate professor of agricultural engineering, University of California (10 min)

3 Agricultural Power from a Power Company Viewpoint—*E. G. Stahl,* San Joaquin Light and Power Association (10 min)

4 Forced Ventilation of Electric Brooders—

(a) *L. C. Moore,* agricultural engineer, Portland General Electric Co. (10 min)

(b) *T. E. Hienton,* agricultural engineer, Purdue University (10 min)

5 Outdoor Brooding of Turkeys—*Paul Ford,* agricultural power salesman, Pacific Gas and Electric Co. (10 min)

III — FARM STRUCTURES DIVISION

(Class Room Building)

Presiding: *R. G. Ferris,* division chairman

1 The Control of Moisture and Temperature in Potato Storages—*A. D. Edgar,* agricultural engineer, U. S. Bureau of Agricultural Engineering (15 min)

2 The Effect of Vapor Pressure Differences on Rates of Drying Ear Corn—*H. J. Barre,* research assistant in agricultural engineering, Iowa State College, and *W. R. Swanson,* junior agricultural engineer, U. S. Bureau of Agricultural Engineering (20 min)

3 Dehydration of Fruits and Vegetables—*E. M. Mrak,* research assistant in horticulture, University of California (15 min)

4 Drying Corn for Safe Storage—*F. E. Price,* agricultural engineer, Oregon State College (10 min)

IV — SOIL AND WATER CONSERVATION DIVISION

(Class Room Building)

Presiding: *T. B. Chambers,* division chairman

1 Water-Holding Capacity of Soils and Its Effect on Irrigation Practices—*Dr. F. J. Veihmeyer,* professor of irrigation investigations and practice, University of California (20 min)

2 Problems of Flow of Water of Special Concern to Agricultural Engineers—*Fred C. Scobey,* senior irrigation engineer, U. S. Bureau of Agricultural Engineering (20 min)

3 Efficiency in the Application of Irrigation Water —*Dr. O. W. Israelsen,* professor of irrigation and drainage engineering, Utah State Agricultural College (20 min)

4 Field Methods of Determining the Consumptive Use of Water—*Harry F. Blaney,* irrigation engineer, U. S. Bureau of Agricultural Engineering (20 min)

2:00 to 5:00 p.m.—Informal Activities

I Group conferences (Class Room Building)

II Trips featuring applications of Farm Machinery and Rural Electrification peculiar to Pacific Coast conditions

III Visits to adobe structures—old and new

IV Recreation—golf, swimming, volley ball, fishing

5:00 to 6:00 p.m.—Annual Business Meeting

(Class Room Building)

8:00 p.m.—Frolic . . Entertainment . . Dancing

(Merrill Hall)

11:00 p.m.—Weiner roast on the beach

WEDNESDAY, JUNE 29

8:30 to 10:30 a.m.—General Program

(Merrill Hall)

Presiding: *Arnold P. Yerkes,* President of the Society

1 Soil Conservation in Relation to Flood Control—*Dr. W. C. Lowdermilk,* associate chief, Soil Conservation Service, U. S. Department of Agriculture

2 Bridging the Gaps—*Leonard J. Fletcher,* agricultural engineer and assistant general sales manager, Caterpillar Tractor Company

3 The Evolution of the Mechanical Cotton Harvester—*E. A. Johnston,* vice-president in charge of engineering and patents, International Harvester Co. (1938 Cyrus Hall McCormick Medalist)

10:30 a. m. to 12:30 p.m.—Technical Programs

I—POWER AND MACHINERY DIVISION

(Merrill Hall)

Presiding: *F. W. Duffee,* division chairman

SYMPOSIUM: Mechanical Cotton Harvesting—Its Engineering, Economic, and Social Aspects

1 Progress in the Mechanical Harvesting of Cotton —*H. P. Smith,* chief, division of agricultural engineering, Texas Agricultural Experiment Station (20 min)

2 Relation of Mechanical Harvesting to the Production of High Grade Cotton—*C. A. Bennett,* senior mechanical engineer, U. S. Bureau of Agricultural Engineering (20 min)

3 Discussions by engineers engaged in the development of mechanical cotton harvesting

II — RURAL ELECTRIC DIVISION

(Class Room Building)

Presiding: *B. P. Hess,* division vice-chairman

1 SYMPOSIUM: Organization for Progress in Rural Electrification

(a) *O. W. Meier,* utilization division, Rural Electrification Administration (10 min)

(b) *C. J. Hurd,* in charge of agricultural engineering development division, Tennessee Valley Authority (10 min)

(c) *E. C. Easter,* agricultural engineer, Alabama Power Co. (10 min)

(d) *J. C. Scott,* agricultural engineer, Puget Sound Power & Light Co. (10 min)

(e) *W. H. Park,* Pacific Gas and Electric Co. (10 min)

(f) *J. S. Webb,* agricultural engineer, Philadelphia Electric Co. (10 min)

2 Committee Reports

III — FARM STRUCTURES DIVISION

(Class Room Building)

Presiding: *J. D. Long,* division vice-chairman

1 The Use of Models for Structural Design—*J. R. Griffith,* professor of structural engineering, Oregon State College (30 min)

2 Soil Stabilization with Asphaltic Emulsion—*R. M. Morton,* vice-president, American Bitumuls Co. (10 min)

3 Marketing a Prefabricated Septic Tank—*Max E. Cook,* agricultural engineer, The Pacific Lumber Co. (10 min)

4 A New Type of Unit Construction for Farm Buildings—*Ray Crow,* sales engineer, Tennessee Coal, Iron, and Railroad Co. (10 min)

IV — SOIL AND WATER CONSERVATION DIVISION

(Class Room Building)

Presiding: *M. R. Lewis,* division vice-chairman

1 Flood Irrigation for Soil and Water Conservation on Range Land in the Southwest—*F. D. Matthews,* regional engineer (Region 8), U. S. Conservation Service (20 min)

2 Water Spreading for Conservation of Excess Runoff—A California Practice—*A. T. Mitchelson* and *D C. Muckel,* senior irrigation engineer and assistant irrigation engineer, respectively, U. S. Bureau of Agricultural Engineering (20 min)

3 Erosion Control on Steep Irrigated Slopes—*Harry E. Reddick* and *J. G. Bamesburger,* regional conservator and regional engineer (Region 10), respectively, U. S. Soil Conservation Service (20 min)

4 The Value of Level Terraces for Dry-Land Farming—*Eugene C. Buie,* associate agricultural engineer, U. S. Soil Conservation Service (20 min)

2:00 to 5:30 p.m.—Informal Activities

I Group conferences (Class Room Building)

II Trips featuring applications of Farm Strucures and Rural Electrification

III Trips to points of interest, including 17-Mile Drive, Point Lobes, Big Sur, glass-bottom boat, San Carlos Mission, Carmel Mission, Monterey, and Carmel

IV Recreation—golf, swimming, games, and contests

6:30 p.m.—Annual Dinner of the Society

(Dining Hall)

Presiding: *Harry B. Walker,* master of ceremonies

1 Award of the F.E.I. student branch cup

2 Award of the John Deere and Cyrus Hall McCormick medals

3 Award of prizes for contests

4 Inauguration of the new President

9:00 p.m.—Fiesta (Merrill Hall)

THURSDAY, JUNE 30

8:30 a.m. to 12:30 p.m.—Technical Programs

I—POWER AND MACHINERY DIVISION

(Merrill Hall)

Presiding: *F. W. Duffee,* division chairman

SYMPOSIUM: Pest Control—Weeds, Plant Diseases, Insects

1 Tillage in Relation to Weed Root Systems—*E. A. Hardy,* professor of agricultural engineering, University of Saskatchewan (10 min)

2 Mechanical Equipment for Weed Control—*D. E. Wiant,* assistant professor of agricultural engineering, South Dakota State College (10 min)

Discussion—*C. W. Smith,* agricultural engineer, University of Nebraska (5 min)

3 Use of Chemicals in Weed Control—*O. C. French,* junior agricultural engineer, California Agricultural Experiment Station (10 min)

Discussion—*H. D. Bruce,* chemist, fire protection, California Forest and Range Experiment Station, U. S. Forest Service (5 min)

(Intermission—10 min)

4 Plant Disease Control Problems of Interest to Agricultural Engineers—*C. Emlen Scott,* extension specialist in plant pathology, University of California (15 min)

5 Equipment to Meet Plant Disease Control Requirements—*V. H. Matthews,* manager, John Bean Mfg. Co. (California) (15 min)

6 The Use of Vapor Spray in Plant Disease Control —*R. M. Merrill,* agricultural engineer, U. S. Bureau of Agricultural Engineering (15 min)

(Intermission—10 min)

(Joint with Rural Electric Division)

7 Use of Light for Grape Leaf Hopper Control—*J. K. Ellsworth,* division of entomology and parasitology, University of California (20 min)

8 Energy Requirements and Safety Features of Electric Insect Traps—*J. R. Tavernetti,* assistant agricultural engineer in the experiment station, University of California (15 min)

9 A Duster for Pea Weevil Control—*F. E. Price,* agricultural engineer, Oregon Agricultural Experiment Station (10 min)

10 Progress of Electric Fence Safety Measures—*F. W. Duffee,* professor of agricultural engineering, University of Wisconsin (10 min)

II — RURAL ELECTRIC DIVISION

(Joint with Farm Structures Division)

(Class Room Building)

1 Fundamental Concepts of Air Conditioning—*R. L. Perry,* assistant professor of agricultural engineering, University of California (30 min)

2 Flow of Heat Through Roofs—*Aldert Molenaar,* graduate student in agricultural engineering, University of California (15 min)

3 Low-Cost Cooling for Residences—*F. C. Fenton* and *C. K. Otis,* professor and instructor of agricultural engineering, respectively, Kansas State College (15 min)

Discussion—*E. E. Brackett,* University of Nebraska (10 min)

4 An Evaporative Cooler—*J. P. Fairbank,* extension agricultural engineer, University of California (15 min)

5 A New Demand for Ventilating and Heating Poultry Houses—*J. C. Scott,* agricultural engineer, Puget Sound Power & Light Co. (15 min)

(Joint with Power and Machinery Division)

(Merrill Hall)

6 Use of Light for Grape Leaf Hopper Control—*J. K. Ellsworth,* division of entomology and parasitology, University of California (20 min)

7 Energy Requirements and Safety Features of Electric Insect Traps—*J. R. Tavennetti,* associate in agricultural engineering, University of California (15 min)

8 A Duster for Pea Weevil Control—*F. E. Price,* agricultural engineer, Oregon Agricultural Experiment Station (10 min)

9 Progress of Electric Fence Safety Measures—*F. W. Duffee,* professor of agricultural engineering, University of Wisconsin (10 min)

III — FARM STRUCTURES DIVISION

(Class Room Building)

Presiding: *R. G. Ferris,* division chairman

(Joint with Rural Electric Division)

1 Fundamental Concepts of Air Conditioning—*R. L. Perry,* assistant professor of agricultural engineering, University of California (30 min)

2 Flow of Heat Through Roofs—*Aldert Molenaar,* graduate student in agricultural engineering, University of California (15 min)

3 Low-Cost Cooling for Residences—*F. C. Fenton* and *C. K. Otis,* professor and instructor of agricultural engineering, respectively, Kansas State College (15 min)

Discussion—*E. E. Brackett,* University of Nebraska (10 min)

4 An Evaporative Cooler—*J. P. Fairbank,* extension agricultural engineer, University of California (15 min)

5 A New Demand for Ventilating and Heating Poultry Houses—*J. C. Scott,* agricultural engineer, Puget Sound Power & Light Co. (15 min)

(End of Joint Session, Intermission, 10 min)

6 Reports of Committees (10 min each)

IV — SOIL AND WATER CONSERVATION DIVISION

(Class Room Building)

Presiding: *T. B. Chambers,* division chairman

1 Flood Control in the Muskingum Watershed Conservancy District—*Bryce C. Browning,* secretary-treasurer, Muskingum Watershed Conservancy District (40 min)

2 Determination of the Safe Yield of a Ground Water Supply by a Simplified Method—*Dr. G. E. P. Smith,* head, agricultural engineering department, and *J. C. Hiller,* assistant agricultural engineer, University of Arizona (20 min)

3 Studies of Runoff from Small Drainage Basins—*D. B. Krimgold,* associate soil conservationist, U. S. Soil Conservation Service (20 min)

(Intermission—10 min)

Presiding: *M. R. Lewis,* division vice-chairman

4 Use of Water by Native Vegetation—*A. A. Young,* associate irrigation engineer, U. S. Bureau of Agricultural Engineering (20 min)

5 Some Observations on the Behavior of Gully Control Structures—*H. B. Roe,* agricultural engineer, University of Minnesota (20 min)

6 Report of Subcommittee on Reservoirs and Ponds —*L. S. Tschudy,* regional engineer (Region 7), U. S. Soil Conservation Service (20 min)

*** * Regular A.S.A.E. Meeting Adjourned * ***

2:30 to 5:00 p.m.—Postmeeting Programs

(Class Room Building)

I Agricultural Engineering Extension Group

II Soil and Water Conservation Group

III Rural Electrification Group

IV Irrigation field trip and/or Western Irrigation and Drainage Research Association Conference

8:00 p.m.—Fireside Chatter

FRIDAY, JULY 1

8:00 a.m.—Postmeeting Inspection Trips

I Soil Conservation Field Trip, Watsonville Area

II Fence Testing Plot Inspection, Santa Cruz

What Agricultural Engineers Are Doing

FROM THE U. S. BUREAU OF AGRICULTURAL ENGINEERING

JOHN C. COTTON spent two weeks visiting the CCC drainage camps in Illinois, Iowa, Missouri, and Kentucky, to review the camp research work on the flow of water in drainage channels. These studies are under the supervision of J. W. Kuhnel, Indiana and Iowa; R. W. De Weese, Ohio; and R. P. Beasley, Missouri and Kentucky. The camps have made approximately 2,000 stream measurements on some 90 selected channel courses.

* * *

W. J. Frere, Jr., superintendent of the drainage camp at Goldsboro, Md., has been appointed drainage inspector for the five camps located in Delaware and Maryland. Mr. Frere began his new duties April 18 at the district office, Camp D-2, Georgetown, Del.

* * *

W. W. McLaughlin represented the Department at a meeting held at Bismarck, N. D., beginning April 18, at which representatives of several federal agencies and five of the northern Great Plains states hope to develop a plan for the stabilization of agriculture in that area.

* * *

For the past three weeks M. R. Lewis has been in the Washington office preparing a design of a reservoir dam for the Southern Great Plains field station of the division of dry land agriculture, Bureau of Plant Industry, located at Woodward, Okla. The dam will be approximately 40 feet high and 1,000 feet long on the crest. The most difficult problem has been the design of a spillway to take care of a maximum flood of 10,000 second feet.

* * *

In connection with the project, Spreading Water for Storage Underground, Dean C. Muckel reports that the floods in southern California during the first week of March raised the flows in most streams beyond the capacity of the diversion works, causing the failure of many structures on the spreading areas. Some damage occurred on all areas set aside for spreading, but in most cases portions of the systems remained and spreading operations were started shortly after the flood had passed. In general, damage was caused by inadequate diversion works and flood channels by-passing the spreading areas. Debris dunes forming in flood channels in many cases caused the streams to break out of their normal courses and cut new channels across the debris cones.

* * *

Colin A. Taylor, taking advantage of the opportunity to make a study of root penetration in orchards and vineyards where floods of March 1 and 2 had undercut trees and vines, visited many of the devastated sections of southern California, making observations and photographing exposed root systems. Some interesting information was obtained as to downward and lateral distribution of roots. For example, a grape vine with 3 feet of stem, growing in Hanford sand, on the Cucamonga wash near Ontario, was found to have 15 feet of roots, extending laterally toward the stream channel.

Contributions Invited

All public service agencies (federal and state) dealing with agricultural engineering research and extension, are invited to contribute information on new developments in the field for publication under the above heading. It is desired that this feature shall give, from month to month, a concise yet complete picture of what agricultural engineers in the various public institutions are doing to advance this branch of applied science.—EDITOR.

* * *

The fifth anniversary of the founding of the Civilian Conservation Corps was observed by central district drainage camps through "open house" celebrations held at the camps. Attendance ranging from 600 to 1,000 visitors gives evidence of the large local interest shown in the men, included talks by civic leaders and camp officials; conducted tours of the camp area showing the shop, garage, offices, living quarters, dining hall; displays of drainage tools and equipment, research work, and educational facilities; and entertainment.

* * *

Although experiencing considerable rain and high water on numerous projects throughout the work areas, there was an increase in total production by the camps during March as preparations for the 1938 construction season are getting under way. The report for the month showed a total of 7,030,000 square yards of clearing, 781,284 cubic yards of excavation and embankment, 15,300 lineal feet of tile reconditioning, and 11,017 man-days on structural and other work.

* * *

Mr. Taylor reports that the advantage of broad, shallow furrows in citrus orchards for controlling runoff was demonstrated during the recent floods. An area of 150 acres of citrus orchards had been laid out with this type of furrow by the division of irrigation in the fall of 1937. A heavy mustard cover crop was disked under in January and new furrows made on one 5-acre area. Even without the protection of the cover crop, no serious damage was done by floods on this area.

* * *

J. C. Marr devoted most of March to analyzing snow cover data. A very satisfactory runoff curve was developed for Snake River above Jackson Lake. It has been found that the precipitation for October and November, as well as for April, May, and June, should be added to the water stored as snow over the watershed to procure a satisfactory runoff curve. Snow surveys have been made on this watershed for 19 years, and afford enough data to assure a fair degree of reliability of the runoff curve.

* * *

Borings, cross-sections, topography, etc., required in connection with plans for the proposed dam to be constructed by the Bureau of Plant Industry at Woodward, Okla., were taken by Harry G. Nickle. Soil samples of the various materials encountered along the axis of the proposed dam and in the spillway area were taken to Austin, where mechanical analysis were made in the Bureau of Agricultural Engineering laboratory. Chemical analyses of water samples obtained at the proposed dam site were made by the University of Texas.

* * *

Orchard soil moisture calibration of the "availabilimeter" was initiated by R. B. Allyn on 38 orchard irrigation blocks at the Medford experiment station. This device is being developed for practical orchard soil moisture determination. Mr. Allyn is also making a study of soil plasticity in terms of moisture content for the purpose of calibrating the availabilimeter.

* * *

Coincident with publication of a report by the National Resources Committee on the Rio Grande Joint Investigation in which the Upper Rio Grande Basin in Colorado, New Mexico, and Texas (which includes as Part III the report of the Bureau of Agricultural Engineering on Water Utilization in that area), is the announcement that the compact commissioners have reached an understanding, subject to approval by their state legislatures, on a new tri-state agreement covering allotment of the waters of the Rio Grande. The compact apportions the total runoff above Ft. Quitman, Texas, and protects existing water use in Colorado, New Mexico, and Texas by establishing schedules of water delivery by Colorado to the Colorado-New Mexico state line and by New Mexico to Elephant Butte Reservoir for use in southern New Mexico, Texas, and Mexico. Years of above and below-average water supply are provided for by a system of debits and credits, with a maximum amount of either. Under this accounting plan the annual release of 790,000 acre-feet of water from Elephant Butte Reservoir is assumed, unlimited reservoir development in San Luis Valley is permitted, and rights of the federal government and treaty obligations to Mexico are protected. (The Rio Grande Joint Investigation report is published as Part VI of the Regional Planning series of the National Resources Committee. Copies may be purchased from the Superintendent of Documents, Washington, D. C., at a cost of $3.50 for the two volumes.)

* * *

The work of E. M. Mervine and S. W. McBirney in developing single-ball sugar beet planters has created much interest because of the saving in seed and reduction in hand labor for thinning. Sugar beet growers are encouraging the commercial adaptation of this type of planter. Test plots are being planted with single seed planters developed by the Bureau as well as with experimental units now undergoing tests by manufacturers.

* * *

J. W. Randolph reports that a large number of field plantings are being made in Alabama with variable depth cotton planters in cooperation with the Farm Security Administration.

* * *

R. B. Gray left Washington April 17 to inspect work *(Continued on page 230)*

NEWS

A.S.A.E. Sponsored Research Project Gets Under Way

FOR SEVERAL months officers of the American Society of Agricultural Engineers have been organizing a research study into the use of pneumatic tires for transport wheels for agricultural equipment. The rapid introduction of pneumatic tires on tractors has furnished the stimulus for the introduction of pneumatic tires for farm machines and vehicles. It was represented that the Society, concerned with the technical and engineering interests of the agricultural and farm equipment industries, could be of most valuable service at this time in arranging for research studies to supply information and basic data which would be used to guide development along the most practicable lines.

Although sponsored by the Society, the researches are supported by a group of farm equipment, tire and rim, and wheel manufacturers, and the Iowa Agricultural Experiment Station. The Society's Committee on Transport Wheels will supervise the studies, and the donors have an advisory group through which advice may be offered. Dr. Eugene G. McKibben of the Iowa station will be in direct charge of the work.

The proposed researches have been outlined in detail and will deal with the efficiency and economy of pneumatic tires for transport wheels, particularly in respect to rolling resistance, protection of machine or vehicle from shock, and the relation of the tire and wheel to the soil. As far as practicable, performance data will be translated into economic or dollar and cents value.

A detailed outline of objectives for the researches is as follows:

1 Determination of the influence of the following physical factors upon the performance and action of transport wheels equipped with pneumatic tires:

(a) Load
(b) Speed
(c) Rim diameter
(d) Tire cross-section
(e) Wheel arrangement, single, dual, tandem, etc.
(f) Rolling resistance
(g) Impact
(h) Soil type (series and texture)
(i) Soil condition (tilth, vegetation, moisture, etc.).

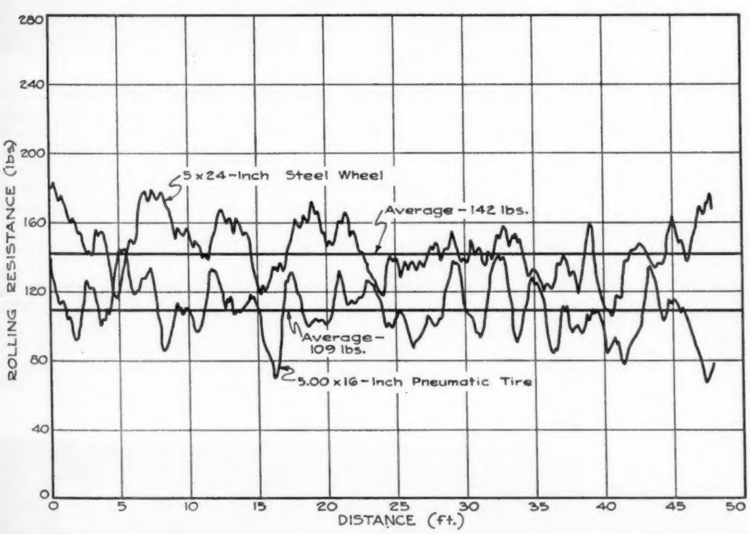
2 Investigation of the effect of pneumatic tires on the cost of field and road transportation considering such influences as

(a) Reduced rolling resistance
(b) Increased field speeds
(c) Life of equipment through protection from shock
(d) Extent of use
(e) Interchangeability of tire equipment between machines
(f) Life of tires.

3 Establishment of the minimum transport tire requirements of various agricultural machines and vehicles under different operating conditions and of the relative merits of different combinations of wheel arrangements, tire dimensions, and air pressure for such situations.

4 Development of more practicable methods of characterizing soils with respect to the resistance offered to the rolling of transport wheels.

THIS PICTURE SHOWS THE DEMONSTRATION OF THE APPARATUS BUILT TO MEASURE THE ROLLING RESISTANCE OF WHEELS MADE BEFORE A CONFERENCE HELD AT AMES, IOWA, APRIL 19. THE GROUP INCLUDES THE PRESIDENT AND SECRETARY OF THE A.S.A.E., MEMBERS OF THE COMMITTEE ON TRANSPORT WHEELS, AND OTHER INTERESTED PERSONS



A GRAPHIC RECORD OF THE ROLLING RESISTANCE OF 5x24-INCH STEEL AND 5x16-INCH PNEUMATIC-TIRED WHEELS WITH A LOAD OF 700 POUNDS ON A FIRM CULTIVATED FIELD

A conference of the Committee on Transport Wheels and others interested was held April 19 at Iowa State College, where it is contemplated that most of the work will be done. The purpose of the conference was to review the proposed program of research and observe in operation the apparatus which has been built for studying rolling resistance. This apparatus gives a graphic record of the rolling resistance of any wheel tested. As a demonstration, tests of the rolling resistance of a 5x24 steel wheel and a 5x16 pneumatic-tired wheel were made on a cultivated surface. It was shown that with a load of 700 lb, the resistance of the steel wheel was 142 lb, while for the pneumatic-tired wheel it was 109 lb—a saving of 33 lb in draft, or over 23 per cent. To illustrate the application of such data, it was suggested that in a case where a drawbar horsepower-hour, represented by a pull of 100 lb at 3¾ mph, cost 8 cents, the saving would be one-third of a horsepower-hour, or 2.7 cents for every hour used.

Those present at the conference included the entire personnel of the A.S.A.E. Committee on Trans- *(Continued on page 230)*

TRACTORS IN TWO YEARS

How a college student started a successful high compression program for Wilson Brothers Implement Co., Minneapolis-Moline dealers, Abilene, Kansas.

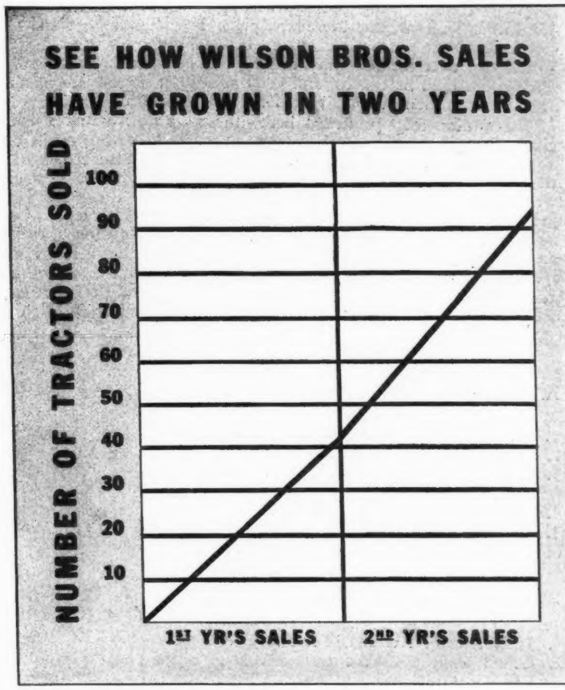
A STUDENT home from college really started Wilson Brothers on their high compression tractor program. Here's how Walter Wilson tells the story:

"We sold our first high compression head about two years ago. A young man at Elmo, Kansas, had gone to the agricultural engineering school at Manhattan. He wanted us to high compression his KTA tractor and said if we did, he could use the same kind of gasoline he used in his automobile. At first, we were dubious how it would turn out, but we did high compression it.

"The results of this test were so convincing that farmers throughout the county soon began demanding high compression heads. We had to change over all tractors that came through from the factory to high compression heads as well as high compressioning tractors already out in the field.

"In our first year in business at Abilene we sold 41 tractors, 38 of which were high compressioned. In our second year in business, we sold 53 tractors and every one was high compressioned.

"High compression heads have cut our free service work, too. Of our past year's sales, more than half the tractors have not had a service call yet, which we consider remarkable trouble-proof performance."



For trouble-proof performance and record-making sales, look squarely at the high compression values your tractor offers. That's what your customers are looking for; they are interested in better performance and fuel economy. Look into the profit possibilities of a thriving changeover business, of converting low compression tractors to high compression with "altitude" pistons or high compression heads. Talk, sell and demonstrate high compression and make 1938 another record year. Ethyl Gasoline Corporation, Chrysler Building, New York, N. Y., manufacturers of anti-knock fluids used by oil companies to improve gasolines.

TRACTORS - *DEMONSTRATE HIGH COMPRESSION*

Anticipation of the A.S.A.E. Annual Meeting

June 27 to 30 - Asilomar, Pacific Grove, California

By J. Dewey Long

NOW THAT it has been decided in fireside council that you will mortgage the old homestead and make a family vacation of the Society meeting in California next month, there are plans to be made. How much time can be devoted to the trip over the necessary driving time, what route shall be chosen, and what scenic and technical interest spots shall be visited?

The outline map presented herewith includes suggestions of western agricultural engineers of the high lights of their respective states. Innumerable others, some of which may be of greater interest to you personally, are not included. If you are to have time to spend in camping or sightseeing in any particular state write to some agricultural engineer of that area for suggestions.

Several of the oil companies provide travel service maps, planned in advance for your trip and giving valuable information on general road conditions, desirable tourist accommodations, and the like. Outstanding is the service provided by Continental Oil Co., Shell Oil Co., and The Texas Co. Application for such service may be made through your local service station on cards which assist in indicating desired routes and main stopping points.

Having credit cards of companies nationwide in scope and with numerous service stations is also desirable. Texaco, Shell, and Conoco have been found outstanding in this respect.

Two or three suggestions for driving hot, arid roads may not be amiss. Don't open the car windows so the wind blows directly on the passengers; open the windshield slightly so the air stream will flow along under the car top and escape out a slightly opened side window. Under exceptional conditions a block of ice or dry ice on the floor of the car is a decided help. When using the latter keep one window slightly open. Doctors advise drinking soda pop rather than water, especially for stomachs that don't feel just right. All drinking, of course, should be in moderation.

Two attractive folders which will help you to better understand the Monterey Peninsula and its historical background are "California Mission Trails," California Mission Trails Association, 412 West Sixth St., Los Angeles, and one published by the Mission Inn, Monterey. Write for copies.

So arrange your arrival at Asilomar on Sunday that you will not be too tired to arise at 4:00 a.m. Monday to view the seashore. The low tide of the year will invite you to walk along sands normally 18 inches beneath the waves and view marine life not often exposed.

Golfers are urged to bring their clubs as the Entertainment *(Continued on page 230)*

KEY TO MAP

A. ASILOMAR

CALIFORNIA

1. U. C. College of Agriculture, Davis
2. Yosemite National Park
3. Lake Tahoe (1926 A. S. A. E. annual meeting site)
4. Lassen Volcanic National Park
5. Redwood Highway
6. Soil Conservation Service, Santa Paula

NEVADA

1. University of Nevada, Reno

ARIZONA

1. University of Arizona, Tucson
2. Grand Canyon of the Colorado
3. Boulder Dam
4. Roosevelt Dam, Mormon Flat, Horse Mesa and Stewart Mt. (The most complete system of water storage for combined power and irrigation on earth.)
5. Casa Grande National Monument
6. Petrified Forest

NEW MEXICO

1. University of New Mexico, Albuquerque
2. Indian Pueblo, Taos
3. Carlsbad Caverns National Park

COLORADO

1. Colorado State College, Fort Collins
2. Rocky Mt. National Park (Estes Park, 1936 A.S.A.E. annual meeting site)
3. Pikes Peak, Colorado Springs
4. Mesa Verde National Park (Cliff dwellings)

UTAH

1. Utah State Agricultural College, Logan
2. Pine View Dam and canal system, Ogden
3. Utah Copper Co. mines; State Capitol building and museum; Saltair Beach, Salt Lake City
4. Bryce Canyon National Park
5. Zion National Park

WYOMING

1. University of Wyoming, Laramie
2. Grand Teton National Park
3. Yellowstone National Park

MONTANA

1. Montana State College, Bozeman
2. Glacier National Park
3. Custer Battlefield
4. Fort Peck Dam
5. "Richest hill on earth," Butte

IDAHO

1. University of Idaho, Moscow
2. World famous highway grade, largest electrified white pine saw mills and Pres-to-log plant, Lewiston
3. Lead and silver mines and smelters, Kellogg
4. "Mighty good fishing", Payette Lakes
5. Shoshone ice caves

WASHINGTON

1. Washington State College, Pullman
2. Mt. Ranier National Park
3. Grand Coulee Dam
4. Olympic peninsula (virgin forest)

OREGON

1. Oregon State College, Corvallis
2. Bonneville Dam
3. Mt. Hood
4. Scenic Coast Highway
5. Crater Lake
6. Oregon Caves
7. Pendleton—"Home of the Roundup"

Georgia State Section of A.S.A.E. Meets

A SPRING meeting of the Georgia State Section of the American Society of Agricultural Engineers was held at the University of Georgia, Athens, on Saturday afternoon and evening, April 23, and Sunday morning, April 24.

The technical session, in the afternoon, featured a rapid fire presentation of short talks on a wide range of subjects, including "Registration of Professional Engineers," "Changes in A.S.A.E., Changes in Curriculum, 1938 Annual Meeting," "Diesel Tractors in Agriculture," "The Place of the Agricultural Engineer in a County Health Program," "Outstanding Results of SCS Projects," "Report of Progress in SCS Districts," "Other SCS Work," "Cotton Ginning in the Extension Program," "Trends in Rural Electrification," "Progress of Hart County Rural Electrification," "Report of Land Mapping in Georgia," and "Report of Research Projects at the Agricultural College."

Following the technical program and business meeting, a short inspection of housing research projects was made.

Ladies of the agricultural engineers were entertained with a bridge party in the afternoon, at the home of Mrs. R. H. Driftmier.

J. W. Simons officiated as toastmaster at the evening banquet. Entertainment features included after-dinner remarks by Peter Brown, head of the English department at the University of Georgia, and musical selections.

An eight o'clock breakfast at Camp Wilkins on Sunday morning concluded the meeting.

W. N. Danner, Jr., chairman of the Section, had the meeting arranged by G. I. Johnson, chairman of the program committee and J. W. Simons, chairman of the banquet committee.

Agricultural Engineers Address Chemurgic Conference

PRESIDENT Arnold P. Yerkes of the American Society of Agricultural Engineers reviewed "Agricultural Engineering Progress" before the Fourth Annual Chemurgic Conference, held at Omaha, Nebraska, April 25 to 27. After summarizing the history and economic significance of agricultural engineering, he suggested its possible usefulness as a cooperating force in the chemurgic movement.

L. F. Livingston (a past-president of the A.S.A.E.) addressed the Conference on "Making Farm Crops More Available for Industry," in which he urged, among other things, increased agricultural engineering research in the direction of improving farm production methods, equipment, and costs to meet industrial requirements for farm-produced materials.

Dr. Harry Miller, of Atchison, Kansas, reported on "New Values in the Castor Bean." This dealt largely with the insecticidal characteristics of some varieties, particularly for attracting and killing grasshoppers, chinch bugs, and other foliage-eating insects. It also mentioned interesting and possibly valuable qualities of the stem fiber, and the familiar oil values, together with its seeding traits and the associated harvesting problem. It was suggested that the combined chemurgic values of the plant, together with plant improvement to facilitate mechanical harvesting, might return it to favor as a farm crop for parts of the United States.

Lamar Kishlar contributed to a discussion of soybean oil.

Wheeler McMillen, as president of the National Farm Chemurgic Council, presided at some of the sessions and was otherwise occupied with keeping the Conference running smoothly.

Other A.S.A.E. members seen in attendance were E. E. Brackett, Harry G. Davis, F. C. Fenton, Henry Giese, R. B. Gray, Fred W. Hawthorn, Arthur Huntington, C. I. Zink, and Frank. J. Zink.

In the business meeting Arnold P. Yerkes was re-elected a member of the Board of Governors of the National Farm Chemurgic Council.

Throughout the program there were frequent references to factors in agricultural and chemurgic progress which involve agricultural engineering. Chemists, plant physiologists, and industrialists reported substantial chemurgic progress and remaining problems in their respective fields.

What Agricultural Engineers Are Doing

(Continued from page 224)

under way on insect pest control machinery at Toledo, Ohio, corn production machinery at Ames, Iowa, and sugar beet production machinery at Fort Collins, Colo. Mr. Gray attended the fourth annual farm chemurgic conference at Omaha, Neb., before returning to Washington.

* * *

G. A. Cumings, accompanied by D. B. Eldredge, left Washington April 13 to conduct fertilizer placement experiments on cotton and tobacco in the southeastern states. Extremely dry weather at Florence, S. C., during the late winter and spring months has made the growing of tobacco plants difficult, with a resulting shortage for early transplanting.

* * *

Fertilizer placement experiments for pasture grass were begun at LaFayette, Ind., by L. G. Schoenleber and D. B. Eldredge early in April. Mr. Schoenleber is now completing the schedule of work on other crops in the Middle West.

* * *

W. H. Redit reports fertilizer placement experiments in progress for cotton, lima beans, and other crops at several points in Georgia and South Carolina.

* * *

Orve K. Hedden returned to Toledo, Ohio, April 15 from Florala, Ala., where he has been since February 1, assisting in the development of burner equipment for use in the control of the white-fringed beetle. A mule-drawn vaporizing type of burner was designed and constructed, making use of commercial burner units.

* * *

Two types of power wheelbarrow sprayers have been constructed in the Toledo shop for use in spraying experimental plots of sweet corn for the control of European corn borer. These sprayers use a ¾-hp gasoline engine for power to drive a reciprocating pump delivering about two gallons per minute at a pressure of 150 pounds. The entire unit weighs about 125 pounds.

* * *

Two corn cribs of new design, being developed by the Carnegie-Illinois Steel Company and associated companies at the suggestion of the Agricultural Adjustment Administration, are on display in the Washington office and have attracted a good deal of attention among Department officials. Full-size models of these cribs are to be erected for testing in connection with the corn storage project at Ames, Iowa.

* * *

C. F. Kelly spent two weeks at Fargo on wheat-storage studies. Six large bins and 8 small bins containing a total of approximately 3,000 bushels are being held for long-time storage studies. All bins were completely sampled to detect trends of moisture movement within the bins due to seasonal variation in temperature.

* * *

W. V. Hukill attended the meeting of the Committee on Hygiene of Housing of the American Public Health Association at Norris Park, Tenn., on April 5 and 6. This committee has formulated 30 principles of housing among which are requirements for temperature control, ventilation, and lighting. He also observed some of the T.V.A. experimental projects at Knoxville and the project on extension of rural lines at Tupelo, Miss.

A.S.A.E. Sponsored Research Project

(Continued from page 225)

port Wheels—J. B. Davidson, Iowa State College (chairman); E. F. Brunner, Goodyear Tire & Rubber Co., representing the tire and rim manufacturers; H. D. MacDonald, International Harvester Co., representing the farm equipment manufacturers; J. H. Ploehn, French & Hecht, representing the wheel manufacturers; R. B. Gray, Bureau of Agricultural Engineering, and I. D. Mayer, Purdue University— and the following other persons: L. B. Neighbor and Mr. Martins, Deere & Co.; R. A. Moyer, Iowa Engineering Experiment Station; L. M. Headley, mechanical engineering department, Iowa State College; C. C. Harrah, National Standard Co.; E. G. McKibben, Iowa Agricultural Experiment Station; Arnold P. Yerkes, president, and Raymond Olney, secretary of A.S.A.E.

Anticipation of the A.S.A.E. Annual Meeting

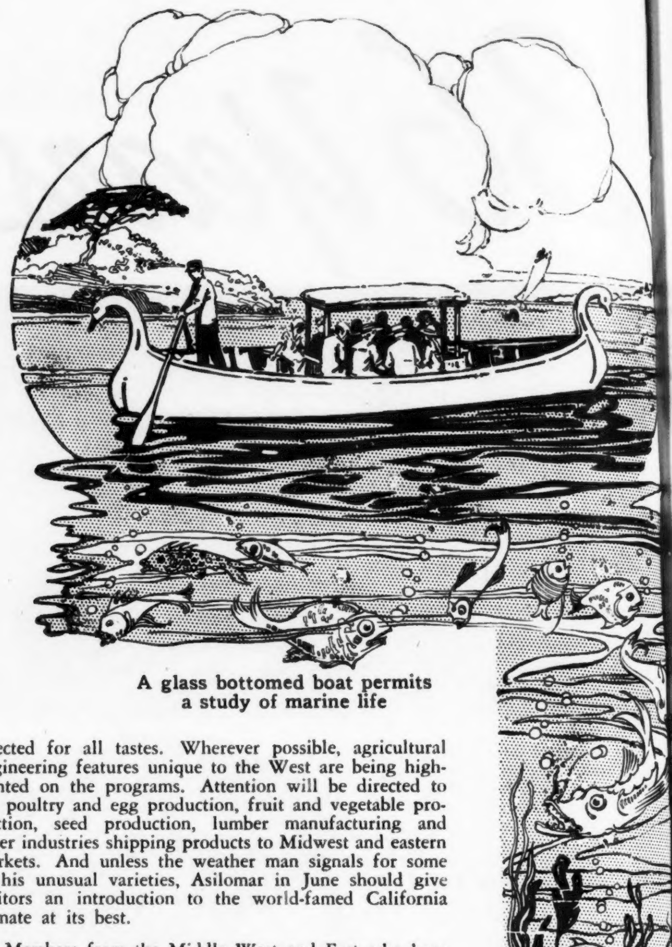
(Continued from page 228)

Committee has arranged a championship tournament for Wednesday afternoon, June 29, on the world famous Pebble Beach course. Two cups are to be awarded, one for low net score and one for low gross. Golfers and would-be golfers are requested to send in their entries with their handicap or last five best scores to R. E. Storie, 320 Hilgard Hall, University of California, Berkeley. Free tickets will be available during the meeting for play on the Pacific Grove course adjacent to Asilomar so golfers may keep in condition.

So plan your stay at Asilomar that you will be able to participate in the post-meeting soil conservation trip on Friday. And if the meeting activities are so strenuous that you need a day or so to rest before starting the trip home we suggest that you continue your reservation at Asilomar. *(News continued on page 234)*

A.S.A.E.
ANNUAL MEETING
June 27-30, 1938

ASILOMAR
"Retreat-by-the-Sea"
Pacific Grove :: California



A glass bottomed boat permits a study of marine life

Forget mundan[e] worries; gaze o[n] other worlds

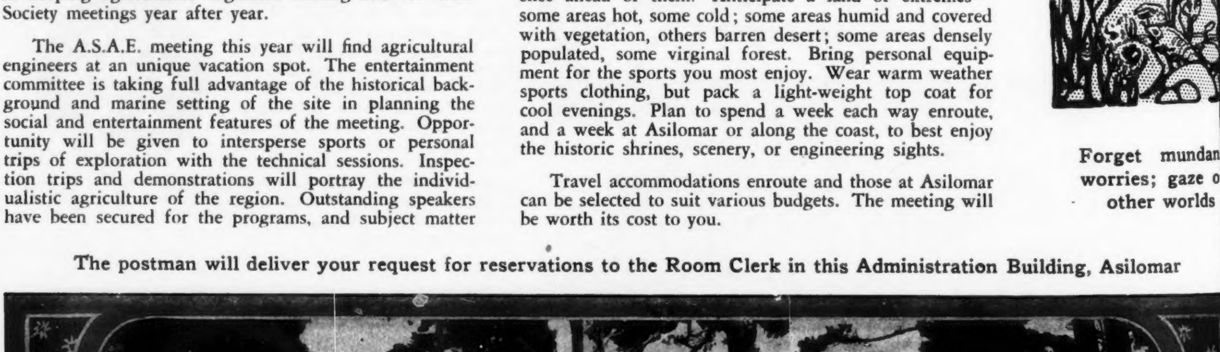
AGRICULTURAL ENGINEERS are noted among technical men for their consistent attendance at the meetings sponsored by their Society. Few similar societies can show a percentage membership attendance at conventions comparable to that of the American Society of Agricultural Engineers. The fact that the membership is small enough to permit wide acquaintanceships and friendships, the stress laid on the family vacation features of the meetings, the earnest efforts of the program chairmen to schedule outstanding papers and to arrange timely discussions, and the fact that agricultural engineering is a rapidly developing field, are undoubtedly large influences in keeping agricultural engineers coming back to their Society meetings year after year.

The A.S.A.E. meeting this year will find agricultural engineers at an unique vacation spot. The entertainment committee is taking full advantage of the historical background and marine setting of the site in planning the social and entertainment features of the meeting. Opportunity will be given to intersperse sports or personal trips of exploration with the technical sessions. Inspection trips and demonstrations will portray the individualistic agriculture of the region. Outstanding speakers have been secured for the programs, and subject matter selected for all tastes. Wherever possible, agricultural engineering features unique to the West are being highlighted on the programs. Attention will be directed to the poultry and egg production, fruit and vegetable production, seed production, lumber manufacturing and other industries shipping products to Midwest and eastern markets. And unless the weather man signals for some of his unusual varieties, Asilomar in June should give visitors an introduction to the world-famed California climate at its best.

Members from the Middle West and East who have never traveled in the West have an interesting experience ahead of them. Anticipate a land of extremes—some areas hot, some cold; some areas humid and covered with vegetation, others barren desert; some areas densely populated, some virginal forest. Bring personal equipment for the sports you most enjoy. Wear warm weather sports clothing, but pack a light-weight top coat for cool evenings. Plan to spend a week each way enroute, and a week at Asilomar or along the coast, to best enjoy the historic shrines, scenery, or engineering sights.

Travel accommodations enroute and those at Asilomar can be selected to suit various budgets. The meeting will be worth its cost to you.

The postman will deliver your request for reservations to the Room Clerk in this Administration Building, Asilomar



Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the April issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Nelson S. Bowsher, secretary, The N. P. Bowsher Co., South Bend, Ind.

Paul C. Broun, student engineer, Tractor Division, Allis-Chalmers Mfg. Co., Milwaukee, Wis. (Mail) 2818 W. Highland Blvd.

George Burnet, associate drainage engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture. (Mail) 955 S. 17th St., Fort Dodge, Iowa.

Ben H. Clark, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Clayton, N. Mex.

James L. Copeman, rural electrification representative, Monongahela West Penn Public Service Co., Fairmont, W. Va. (Mail) Hillcrest Road.

G. E. Cubberly, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 111 Russell Street, Crewe, Va.

George H. Dunkelberg, instructor and research assistant, Agricultural Engineering Department, Iowa State College, Ames, Iowa.

C. E. Everett, engineer, Harvester Division, The Massey-Harris Co., Inc., Racine, Wis. (Mail) 3816 Kinzie Ave.

Richard K. Frevert, instructor, Agricultural Engineering Department, Iowa State College, Ames, Iowa. (Mail) 217 Ash Ave.

Roy J. Gardner, junior agricultural engineer, Soil Conservation Service. U. S. Department of Agriculture. (Mail) Box 333, Chamberlain, S. Dak.

M. T. Gowder, assistant extension agricultural engineer, Extension Service, University of Tennessee, Knoxville, Tenn. (Mail) 1515 W. Cumberland Ave.

Harry Grayson, associate supervisor, Thumb Electric Cooperative, Ubly, Mich.

George Hardman, state coordinator, Soil Conservation Service, U. S. Department of Agriculture, Region X. (Mail) Morrill Hall, University of Nevada, Reno, Nev.

Albert L. Hill, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 409 Walnut St., Washington, Mo.

L. L. Kelly, assistant hydraulic engineer, Soil Conservation Service. U. S. Department of Agriculture. (Mail) 1116 N. 38th St., Lincoln, Nebr.

Johan A. Krabbe, assistant agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Simnasho, Ore.

Carl J. Lowry, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 316 Farnham St., Shenandoah, Iowa.

Norman E. Macpherson, assistant engineer, Municipal Engineering Department, Hydro Electric Power Commission of Ontario, Toronto, Canada. (Mail) 42 Donegal Dr., Leaside, Ontario, Can.

John L. Marsh, engineering department, J. I. Case Co., Rockford, Ill. (Mail) 2316 Hancock St.

Edward W. Martin, engineering aide, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Box 968, Mt. Pleasant, Tex.

Frank C. Mohler, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 541 S. Webster St., Ottumwa, Iowa.

Toyohiko Nibosi, engineer, Bureau of Industry, South Manchuria Railroad Co., Dairen, Manchuria.

Henry Otterson, farm manager and agricultural consultant, Genesee Depot, Wis.

Cloyce L. Parish, acting project manager, Soil Conservation Service. U. S. Department of Agriculture. (Mail) 736 High St, Hamilton, Ohio.

Alfred H. Powell, associate professor, Farm & Automobile Mechanics, Utah State Agricultural College, Logan, Utah.

T. P. Powell, teaching fellow, Agricultural Engineering Department. University of Idaho, Moscow, Idaho. (Mail) 325 N. Polk St.

Frazier Rogers, professor of agricultural engineering (head of department), University of Florida, Gainesville, Fla. (Mail) 150 S. Palmetto St.

Albert M. Setter, rural electrification representative, Puget Sound Power & Light Co., Chehalis, Wash. (Mail) 1702 Chehalis Ave.

J. E. Smith, assistant county agent, Boydton, Va. (Mail) Chase City, Va.

R. B. Stamey, assistant agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 211 E. Green St., High Point, N. C.

Arthur N. Thomas, consultant, farm lighting and water systems, 2207 Adelbert Road, Cleveland, Ohio.

S. J. Wright, director, Institute for Research in Agricultural Engineering, University of Oxford, Parks Rd., Oxford, England. (Mail) 10 Parks Rd., Oxford, Eng.

Robert E. Yoder, professor of agricultural engineering, (acting head of department) Alabama Polytechnic Institute, Auburn, Ala.

Vilas D. Young, associate hydraulic engineer, Soil Conservation Service, U. S. Department of Agriculture, Washington, D. C. (Mail) 4491 Conduit Rd., N.W., Apt. 203.

TRANSFER OF GRADE

Thomas L. Baggette, assistant agricultural engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture. (Mail) Box 91, Leland, Miss. (Transfer from Junior Member to Member.)

Rollie N. Blancett, junior civil engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture. Box 755, Milwaukee, Wis. (Transfer from Junior Member to Member.)

Robin H. Burnette, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) SCS-CCC-Nc Camp No. 20, Ramseur, N. C. (Transfer from Junior Member to Member.)

James C. Carrigan, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) CCC Camp SCS-Neb-7, Weeping Water, Nebr. (Transfer from Junior Member to Member.)

Clark T. Cheney, camp Superintendent, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 306 S. Elm St., Shenandoah, Iowa. (Transfer from Junior Member to Member.)

Bernard T. Colley, metallurgical engineer, general superintendent, manager of farms, Cerro de Pasco Copper Corp., La Oroya, Peru. (Transfer from Associate Member to Member.)

Max E. Cook, agricultural engineer, The Pacific Lumber Co., 1134 Excelsior Ave., Oakland, Calif. (Transfer from Member to Fellow.)

Lowell M. Graves, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Box 253, Alcester, S. Dak. (Transfer from Associate Member to Member.)

John R. Haswell, professor of agricultural engineering extension, division of agricultural extension, Pennsylvania State College, State College, Pa. (Mail) The Orlando. (Transfer from Member to Fellow.)

O. W. Israelsen, professor of irrigation and drainage engineering, Utah State Agricultural College, and irrigation and drainage engineer, Utah Agricultural Experiment Station, Logan, Utah. (Transfer from Member to Fellow.)

Melville M. Johns, agricultural extension service, University of Tennessee, Knoxville, Tenn. (Transfer from Junior Member to Member.)

George R. Louthan, designer, John Deere Spreader Works, East Moline, Ill. (Mail) 1130 Eighth St., Moline, Ill. (Transfer from Junior Member to Member.)

Philip W. Manson, instructor, agricultural engineering department, University of Minnesota, St. Paul, Minn. (Mail) 1471 Raymond Ave. (Transfer from Junior Member to Member.)

J. T. McAlister, associate regional engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 707 E. Main St., Spartanburg, S. C. (Transfer from Member to Fellow.)

Dalton G. Miller, senior drainage engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture. (Mail) University Farm, St. Paul, Minn. (Transfer from Member to Fellow.)

Charles K. Otis, instructor, agricultural engineering department, Kansas State College, Manhattan, Kans. (Mail) 1614 Humboldt St. (Transfer from Junior Member to Member.)

A. J. Schwantes, associate professor of agricultural engineering, University of Minnesota, St. Paul, Minn. (Transfer from Member to Fellow.)

J. Macgregor Smith, professor of agricultural engineering, University of Alberta, Edmonton, Alta., Canada. (Transfer from Member to Fellow.)

H. P. Twitchell, agricultural engineer, Farm Security Administration, 342 Massachusetts Ave., Indianapolis, Ind. (Mail) 60 Northridge Rd., Columbus, Ohio. (Transfer from Junior Member to Member.)

H. B. White, division of agricultural engineering, Department of Agriculture, University of Minnesota, St. Paul, Minn. (Transfer from Member to Fellow.)

W. Leland Zink, chief engineer, David Bradley Mfg. Works, Bradley, Ill. (Mail) Plano, Ill. (Transfer from Member to Fellow.)

Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, principal agricultural engineer, Office of Experiment Stations, U. S. Department of Agriculture.

CELLAR AND COLD STORAGE OF SOUND AND MECHANICALLY DAMAGED TRIUMPH SEED POTATOES, *H. O. Werner.* Nebraska Sta. Res. Bul. 88 (1936), pp. 59, figs. 25. The relative desirability of cellar storage or cold storage during various periods was determined by considering the weight loss when Triumph potatoes were stored in crates and their field performance when planted.

The storage of sound potatoes.—Cold storage from harvest to planting resulted in less weight loss and in a higher percentage of sound potatoes than did cellar storage. With late-June planting, emergence was slightly slower from cold storage than from cellar-stored potatoes, but the stands and total yield were better. Cold storage within a few weeks or just after harvest, if continued until a week or two before planting, generally resulted in increased weight losses, because of greater rotting, but did not appear to affect yields the next year. When potatoes were placed in cold storage about the time cellars began to warm up or about when buds began to elongate into sprouts (in April), the most desirable and economical method used, losses due to sprout growth and decay were not serious, the percentage of sound tubers was almost as great, and yields were about as high as with longer cold storage. Cold storage beginning in late May or early June was less desirable than earlier transference to cold storage but preferable to continual cellar storage, provided sprouting was not advanced too far. When cold storage was begun in the fall, its continuance until early June was found desirable. A warming up period in the cellar of 2 or 3 weeks instead of from 5 to 7 days before planting increased weight losses, sprout growth, and usually the amount of decay, but generally did not increase yields significantly. Cold storage in spring was more essential for potatoes subjected to fall cold storage than for those that had fall cellar storage.

Storage losses under various treatments always were greater with immature tubers than with sound, mature tubers. Best stands and highest yields were generally secured from seed in which sprout growth was well initiated throughout the tuber. Solid, almost completely dormant potatoes produced better stands and yields than tubers severely shriveled because of extensive loss of water and sprout growth. Potatoes stored in sacks lost less weight during the fall and winter but more in the spring than those stored in crates. There was less sprout growth and rot with crate storage, probably due to differences in aeration.

The storage of mechanically damaged potatoes.—Weight losses were always greater with mechanically injured than with sound potatoes stored under the same conditions. Under best conditions, sound potatoes in June constituted from 85 to 89 per cent of the October weight with whole potatoes as compared with from 56 to 68 per cent when tangentially cut tubers were stored. With cut potatoes, differences in weight loss generally were accounted for by the amount of rot. Losses in storage rose as the severity of the damage to tubers increased—the severity increased with the area of the cut or damaged surface. Exposure of cut potatoes to sunshine increased weight loss and amount of rot, especially as exposure was prolonged. Exposures to sunshine of from 4 to 8 hr resulted in almost complete destruction of the potatoes by June when cellar storage was used. With cut surfaces turned away from the sun, exposure resulted in more loss than when cut tubers were taken into the cellar at once, but much less than when cut surfaces were toward the sun. Subsequent loss increased with length of exposure of such cut tubers to the dry air, wind and sun. As the humidity of the cellar rose the less was the weight loss and percentage of rot.

Cold storage any time before April 1 always resulted in increased weight loss and rot. Freshly cut potatoes held in a cellar 1 week and then moved to cold storage lost less weight than when put into cold storage just after cutting or if held in cold storage for only the first week just after cutting. Cellar storage until April 1 and cold storage after that gave satisfactory results but not much better than continual cellar storage. When potatoes were cut into seed-size pieces in early October, about half of the original weight remained as sound seed pieces by June 15. The losses generally increased as the severity of the exposure increased, due either to more time, brighter sunshine, less humidity, or more wind. Effects of exposure temperature were less apparent within the range of conditions experienced.

EFFECT OF LIGHT INTENSITY ON THE PHOTOSYNTHETIC EFFICIENCY OF TOMATO PLANTS, *A. M. Porter.* Plant Physiol., 12 (1937), No. 2, pp. 225-252, fig. 1. In this study by the Michigan Experiment Station, Grand Rapids Forcing tomatoes were grown under average daily light intensities of 1,139.9, 583.1, and 261 footcandles, with the following results: The stem elongation and leaf-area expansion responses were both continuously and finally greater with the lower light intensities. When the light intensity reached a definite average the fruit set rather freely and developed. The percentages of dry matter, ash, water, fresh weight, and elaborated food materials correlated rather closely with the light intensity supplied. Light intensity proved to be the chief cause of differences in plant efficiency. Basal metabolism and its contributing factors were regulated by the amount of light received by the plants. The increase in multiple over simple correlations under each degree of light intensity furnished evidence of interrelationships between factors regulating plant food manufacture. The coefficients of determination demonstrated that light intensity alone accounts for 32.4 per cent of the photosynthate variation, and that temperature and humidity are negligible factors only when correlated with light intensity—humidity becoming a critical factor in photosynthesis when light intensity is reduced.

Light intensity appeared to have a regulatory influence on the average amounts of chlorophyll per unit leaf area. The chloroplasts arranged themselves for the highest reception of light when the latter was reduced. In shaded plants the leaf anatomy was abnormal, consisting of loosely arranged, irregular spongy parenchyma cells and a reduction in the size, density, and number of palisade cells.

The average light intensity of 1,139.9 footcandles daily during growth had a greater effect in promoting chlorophyll formation, fruit production, and photosynthetic efficiency in tomatoes than the daily average of 583.1 footcandles. This, in turn, had a greater effect than the daily average of 261 footcandles.

THE RELATION BETWEEN PENETRATION AND DECAY IN CREOSOTED SOUTHERN PINE POLES, *R. H. Colley and C. H. Amadon.* Bell Tel. System, Tech. Pubs., Tel. Equip. Monog. B-937 [1936], pp. 17, figs. 9. The detailed results of an increment borer study of over 3,000 creosoted southern pine poles standing for various periods up to 26 yr in Florida, North and South Carolina, Tennessee, Virginia, Illinois, Wisconsin, Michigan, and New Jersey showed internal sapwood decay only in those instances where the creosote had failed to penetrate 75 per cent of the thickness of the sapwood.

IRRIGATION EXPERIMENTS WITH THE EARLY GRANO ONION, *A. S. Curry.* New Mexico Sta. Bul. 245 (1937), pp. 39, figs. 12. Beginning about 6 weeks after transplanting, five different irrigation treatments were compared on quadruplicated plats. A summation of 5 years' work showed the highest average yield and the highest average percentage of No. 1 bulbs on the plants receiving the most frequent irrigation and the greatest amount of water. At the same time the treatment with the smallest number of irrigations and the smallest amount of water returned the lowest yields and the lowest percentage of No. 1 bulbs. It was not possible to associate premature seedstalk formation with any irrigation treatment, but there was some evidence that time of maturity is related to the water supply. The onions on the most abundantly irrigated plats tended to mature last and those on the least irrigated plats first.

Soil-moisture determinations showed the greatest use of water in late May and early June. A tight layer of clay about 5 or 6 ft below the surface interfered with the downward movement of water and resulted in some difficulty in establishing definite water tables.

Storage studies with onions from the different treatments gave indication that the most frequently irrigated bulbs kept somewhat better and suffered less weight loss in storage. In 1934, a season favorable to the development of thrips and pink root rot, it was impossible to establish the relationship between extent of injury and the differential treatments. *(Continued on page 238)*

Agricultural Engineering Digest

(Continued from page 236)

A STUDY OF OVENS USED FOR DOMESTIC COOKING PURPOSES, *G. M. Redfield.* Indiana Sta. Bul. 416 (1936), pp. 20, figs. 12. The author compared the radiation losses, operation costs, and temperatures maintained under various conditions of operation, heat retention, and distribution, the accuracy of thermostatic controls, and the thermal efficiencies of five standard electric range ovens, one gas range oven using city gas, the same oven equipped with conversion burners and used with bottled gas, and an oven specifically designed for use with bottled gas.

A measurable variation was noted in the radiation losses computed per 1,000 m^2 of inside oven surface. The electric ovens required less time for preheating and more energy than did the gas ovens, and also showed better heat retention. This indicates that cooking will continue longer after the heat is turned off in the electric ovens tested than in the gas ovens. In all ovens the heat was distributed fairly uniformly and without sufficient variation in temperatures in different parts of the oven to cause variations in the brownness of baked products. The thermal efficiencies in the electric ovens varied from 26.15 to 32.18 per cent and in the gas ovens from 14.25 to 18.21 per cent. The electric ovens required from 344 to 587 watts to preheat to 325 F, from 256 to 485 watts to maintain this temperature for 1 hr with the oven empty, and from 435 to 656 watts to bake a sponge cake. In the gas ovens the city gas range equipped with conversion burners required the least expenditure of heat units, followed by the regularly equipped bottled gas range and the city gas range. The temperature variations for a given thermostat setting were found to be much greater in the electric than in the gas ovens. The gas ovens maintained a more even temperature than did the electric ovens, although either gave satisfactory results.

THE EFFECT OF ELECTRIC CURRENT ON CERTAIN CROP PLANTS, *C. S. Dorchester.* Iowa Sta. Res. Bul. 210 (1937), pp. 37, figs. 9. The possible effects of weak electric currents, similar to those existing in nature, upon crop plant growth and certain phases of the environment were studied in experiments using the earth-air currents collected and discharged by means of elevated metal brushes, and using currents generated as the result of differences in potential between buried, aerially connected, copper and zinc electrodes, sometimes augmented by dry cells placed in the circuits. In both types the currents developed were applied to the root areas of the plants.

Currents obtained by installation of elevated metal brushes connected with buried wires transversing the root areas of field crops apparently had little effect on yields of corn, soybeans, turnips, string beans, chard, and beets, the last two making the largest increases. Currents passing through elevated metal brushes during fair weather changed direction frequently and were of the order of from 5×10^{-10} amps to 1×10^{-9} amps, but varied greatly during unsettled weather both in direction and magnitude, the highest value being of the order of 200×10^{-9} amps. Intensities of currents measured in the soil and along the buried conductor at various distances from one of the elevated brushes seemed to bear no relation to intensities measured where the conductor entered the soil.

Application of currents ranging in intensity from 7,000 to 20,000 volts to roots of oats in greenhouse flats did not produce significant variations in yields of grain and straw. Greenhouse treatments in which an electrode of copper and one of zinc were buried at opposite ends of the test soil area and connected aerially by copper wire produced significant increases in yields of oats in the first year of the experiment. Currents measured were of the order of from 0.5 to 1.5 ma. In the second year the grain and straw yields were not increased by treatment with electric current, while root yields were decreased significantly. In this test one or two dry cells were included in the circuit for each treated lot, and current intensities ranged as high as 4 ma. In field trials with oats the copper-zinc electrodes combination, with dry cells included in the circuits, provided current intensities ranging from 2 to 55 ma but failed to affect yields significantly, and apparently did not affect the percentage of total nitrogen of oats.

Except in determinations made in connection with the field tests, a rather definite relationship between electrical treatment and numbers of soil microorganisms was observed throughout the series of experiments. In the 1932 greenhouse experiment, comparison of 24 samples showed increases for the electrically treated lots of from 14 to 123 per cent and for 20 samples in 1933 of from 15 to 23 per cent. Further proof was provided by the carbon dioxide determinations, a weak current of 0.1 ma producing appreciable increases in amounts of carbon dioxide formed and a relatively strong current of from 10 to 15 ma resulting in pronounced decreases. *(Continued on page 240)*

MAN'S ALLY . . .
in Reshaping the Earth's Surface for Man's Utility

TracTracTors are particularly adapted to farm terracing where soil erosion control is practiced. The Model TD-40 TracTracTor is shown above pulling a terracer

Right: A TracTracTor on a highway project. The disk harrow packs the fill after the side-connected bulldozers have done their work

MAN is constantly at work reshaping the earth's surface to aid agriculture, commerce, industry — and not the least important, to help his fellow man enjoy his leisure more fully. The job may be one of terracing hillsides to control soil erosion. It may be grading a road. It may be leveling ground for a new park or a golf course fairway.

Wherever there is a call for heavy-duty power, you'll find International Harvester TracTracTors a splendid choice for the job. On every operation, they are making enviable records for performance, economy, accessibility, and long life. These records are all a result of sound, practical engineering principles that Harvester has adhered to through all the years of tractor manufacture.

There are five TracTracTors, including two Diesels. Ask the nearby International Harvester dealer or Company-owned branch for the answer to your power problems. Or, write us for complete information.

INTERNATIONAL HARVESTER COMPANY
(INCORPORATED)
180 North Michigan Avenue Chicago, Illinois

International Harvester TracTracTors

Agricultural Engineering Digest

(Continued from page 238)

A STUDY OF EFFICIENT KITCHEN ARRANGEMENTS, *G. M. Redfield.* Indiana Sta. Bul. 418 (1937), pp. 29, figs. 14. The results of a survey made of 774 rural Indiana kitchens showed that many are inadequately equipped, inefficiently arranged, and vary in size from 6 by 7 ft to 24 by 24 ft. A kitchen 12 ft wide by 15 ft long was selected as a standard and was set up in the laboratory and equipped with a range, refrigerator, sink, kitchen cabinet, serving table, chair, and storage cabinet, and space was allowed for 3 doors and 2 windows. The equipment was rearranged in 28 different ways and the relative efficiencies of the different arrangements were determined by four tasks—the making of a plain cake and an apple pie and the preparation of a single meal and of a day's meals. A process chart was worked out for each task and varied to fit each arrangement.

In a well-equipped and well-arranged kitchen the housewife should be able to start at the storage center and carry through the meal preparations to the dining table with little retracing of steps or crossing from one work space to another. In a long narrow kitchen the equipment should be arranged around the end of the room, while in a square kitchen an L-shaped arrangement is more efficient. Work surface heights between 32 and 34 in are satisfactory for the woman of average height. Sufficient light should be available at all work centers. The survey of kitchen storage needs disclosed the fact that storage space must be provided in or near the kitchen for about 450 items of canned goods, 30 kitchen utensils, 100 dishes, 72 pieces of silver, 66 pieces of linen, 15 to 20 bulk items such as cereals, 36 cakes of soap and 7 brushes and handled cleaning tools. "Since farm homemakers spend an average of 54 hr a week in homemaking activities, the kitchen should receive more thought and attention when planning the house than any other room."

STRAWBERRIES UNDER NEON LIGHT, *J. W. M. Roodenburg.* Jour. Roy. Hort. Soc., 61 (1936), No. 12, pp. 504-509, pls. 4, fig. 1. Provided that irradiation of strawberry plants of the Deutsch Evern variety was begun in early October before naturally short days and low temperatures had induced a condition of rest, it was possible to continue the plants in a vegetative condition with abundant flower formation and early fruit. Otherwise, it was necessary to submit the plants to low temperature and begin forcing about New Year's Day.

Literature Received

"FARM FENCE HANDBOOK," by Henry Giese, is a paper-bound booklet of 64 pages, 8½x11 inches, published by the Agricultural Extension Bureau, Republic Steel Corporation. It states briefly information on the need of fencing, history of fence materials and design, modern fence manufacturing processes, principles of selection, how to erect and maintain fences, and miscellaneous useful fence information. Available on request to the publisher, 7850 South Chicago Ave., Chicago, Illinois.

EMPLOYMENT BULLETIN

The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted." or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.

POSITIONS OPEN

AGRICULTURAL ENGINEERS wanted to sell lightning protection equipment and fire alarm systems. Dealer arrangement, or opportunity available to sell for the factory, or for an established dealer. Opportunity to make a profit and to render a worthwhile fire prevention and safety service. PO-121

POSITIONS WANTED

MECHANICAL ENGINEER, with eighteen years' experience supervising engineering work on heavy farm machinery, is available for a position of a similar nature. PW-288

AGRICULTURAL AND CHEMICAL ENGINEER, with nine years experience in agricultural engineering teaching and research and two years industrial experience, desires position in either teaching or research. Age 35. Married. PW-289